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Army Ordnance Association — Election — Constitution and By-Laws — Send Ballot on Page 49 To-day

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ARMY ORDNANCE

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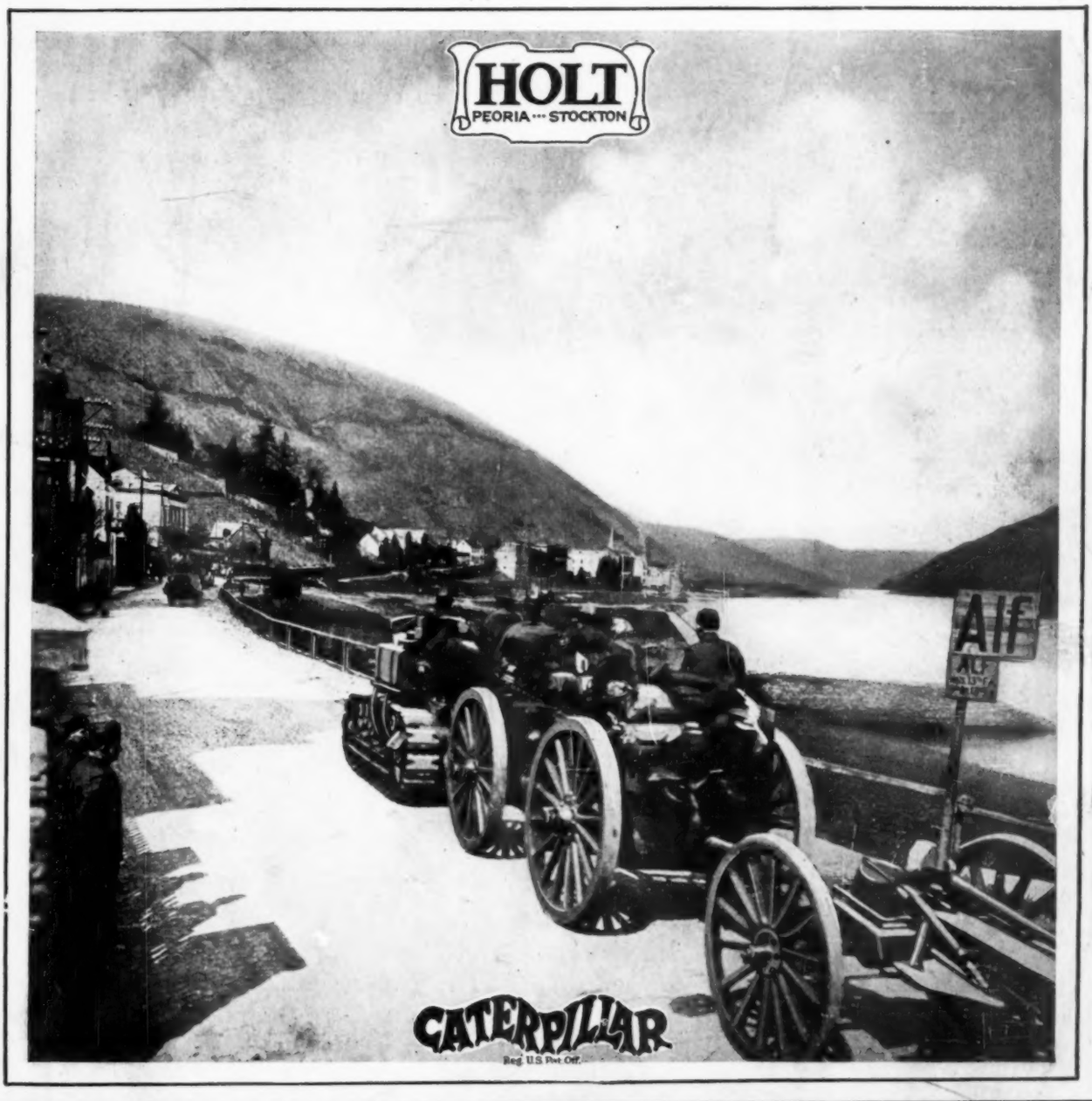

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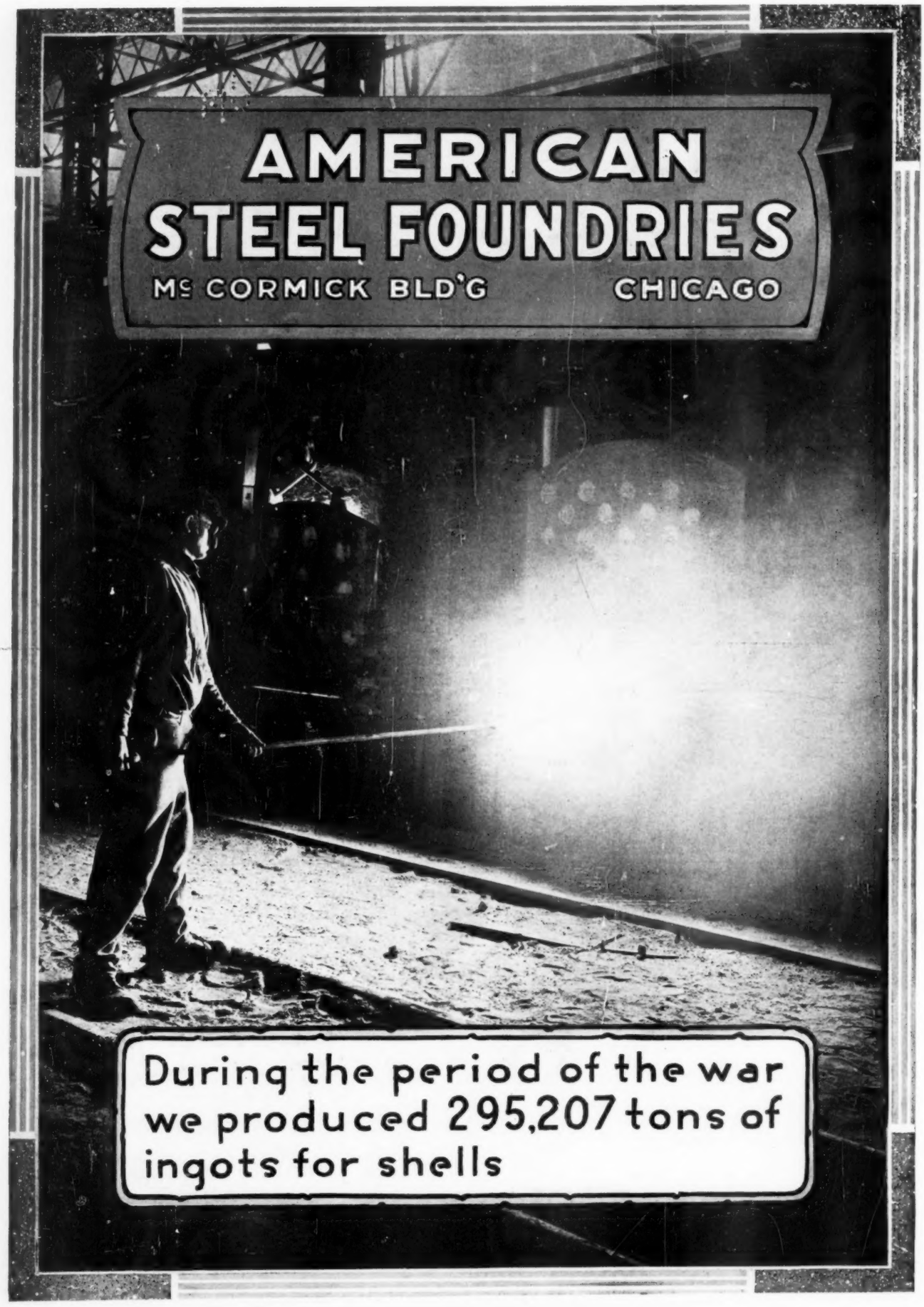
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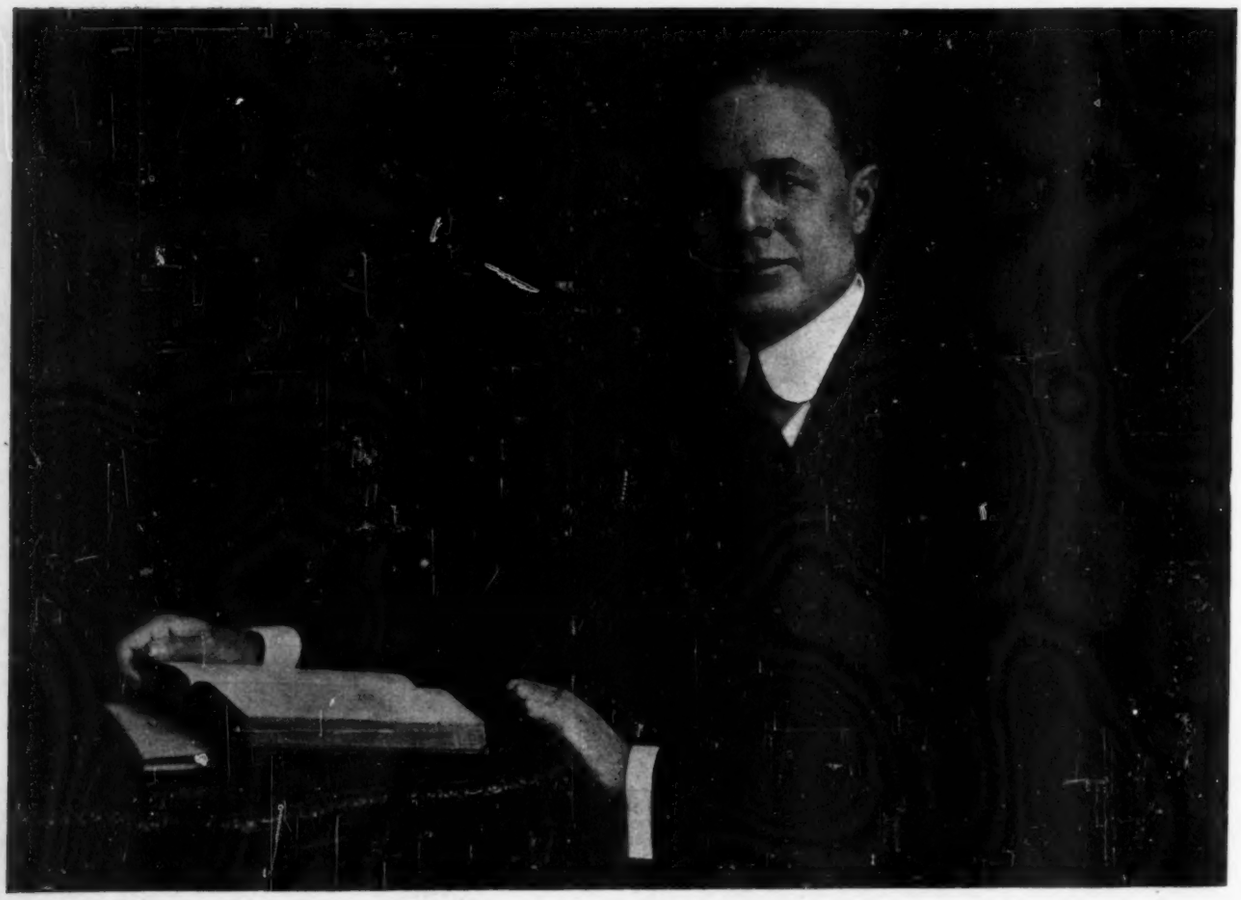

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BENEDICT CROWELL
Assistant Secretary of War
Director of Munitions
1917-1920

First Nominee for President
Army Ordnance Association

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

VOL. I WASHINGTON, D. C., JULY-AUGUST, 1920. No. 1

Decentralized Production

By

GUY E. TRIPP
Charter Member A. O. A.
Chairman Board of Directors, Westinghouse Electric and Manufacturing Company

AS I understand the aims of the magazine, it is not the plan of ARMY ORDNANCE to become the vehicle of the historian. The story of effort and achievement during the perilous nineteen months of our participation in the war has been and will continue to be told elsewhere. Yet, in order to understand conditions which must be met in certain future contingencies, it is necessary to enter in some degree into a discussion of past performances. The vision of the future is necessarily influenced by experiences which have gone before, and no true sense of perspective may be had except through consideration of outlying and underlying influences.

Brig. Gen. Guy E. Tripp

For that reason it seems best at the very outset of the career of ARMY ORDNANCE to tell of the conditions which existed and which had to be faced by the Ordnance Department on April 6, 1917, when it was called upon to undertake the solution of the most stupendous manufacturing problem in all history. As an individual unit the Ordnance Department, when we entered the war, became a part of the "Inter-allied Munitions Pool," with certain well-defined activities and duties set apart for it; and, while becoming a part of this larger unit, the Ordnance Department divided itself into thirteen smaller ones — for reasons which are set forth here.

Early in the war it became apparent that the vast amount of work to be done, the tremendous number of contracts to be made, and the almost unending amount of territory covered by the industrial army of makers of Ordnance material, could not be handled from a single central point—Washington. The distances between control base and outlying districts were truly magnificent. At that time we had not heard of Einstein's theory of relativity, but we did face the fact that time and space were relative—that intervening space would cause delays in time which might prove fatal. The obvious thing to do was

to decentralize the organization. The consequent dividing of the Ordnance Department into thirteen districts, each with its own chief, who was in effect a Chief of Ordnance, was the result.

Yet, in the beginning, it was not so obvious as it now appears. The thing was without precedent. Tradition called for the centralization of power, but the saner argument won, and tradition and precedent were broken.

After all, it was really an adaptation of the methods of "big business" as known in the commercial world, to the biggest business, the greatest industrial organization the world has ever known. Late in 1917 some tentative efforts had been made in the Ordnance Department looking toward the decentralization policy, but it was not until January, 1918, that the system became an orderly structure. Even then the time element forbade detailed planning, and each District Chief was allowed to set up his own organization. It was hoped by frequent conferences that co-ordination would become complete and that unification would result.

In the beginning of the work under these new conditions it had been pointed out by conservatives that the system was not only without precedent, but that it violated all known laws of government procedure and was totally without logical foundation, and, indeed, it seemed to the Chief of Ordnance and those who helped in working out the plans, that the only safe base upon which to build, lay in the selection of the right men to carry out the ideas presented. That these men were found, that the plan was right—that it worked, and that the outcome was as it should have been, finds sufficient justification in the fact that the men thus chosen received the Distinguished Service Medal from the President at the hands of Honorable Benedict Crowell, Assistant Secretary of War, Director of Munitions, at the first annual meeting of the Army Ordnance Association in October, 1919.

It would be useless to speculate upon what might have happened if this policy of decentralization had not been carried out, but there are men who can surmise. These are the ones who saw the congestion at Washington even after twelve production districts had been organized outside. Briefly, it would have been physically impossible to handle the amount of detail that would necessarily have flowed into The Ordnance Office. No one could have been entirely familiar with conditions pertaining to the copper and brass industries of the New England District, the walnut and other timber problems of the Southwest, the tanks and tractors of the mid-west, the powder industries of Delaware, New Jersey, and other localities, the toluol plants, the nitrates, or, in short, a complete knowledge of the production of about 100,000 separate items of manufacture comprehended under the general term of Ordnance.

Logic or no logic, the plan of "self-determination" worked out, and if ever an end justified the means, this one did.

It has been the policy of the United States—in fact it has been a matter of law—that such articles of war as are not regularly manufactured in its Arsenals must be procured in the open market. No provision has ever been made which guarantees that the open market is capable of producing the articles so required. This has now been demonstrated to the vast disappointment of the believers in the million-men-over-night idea and its concomitant fallacies.

It is not conceivable that those who preach unpreparedness would conduct their own business on such lines. It is unbelievable that they would ask their man-of-all-work to mow the lawn, knowing well enough that they themselves had locked the lawn mower in the toolhouse, unless they imagine that by providential intercession, munitions of war come into being in the manner in which Elijah achieved food—through the courtesy of some friendly ravens.

The fallacy of this attitude—this idea of unpreparedness—has been proved by the expenditure of blood and tears and treasure, but it is probable that the lesson may soon be forgotten unless an effort be made to preserve it through some organized effort.

It is this lesson which The Army Ordnance Association seeks to keep in the public mind. The Association is in itself the logical outcome of the decentralization of Ordnance work during the war. Its organization parallels to all intents and purposes that of the Ordnance Department, and its division into district units follows the Ordnance plan. Through the channels proposed in this system it is possible to keep up a connection between Ordnance and the producers of munitions, or, rather, the potential producers of material, to the end that in an emergency there may be already in existence an effective preparedness in this Department. The system of dissemination of knowledge and arousing widespread interest by means of decentralization has been proved sufficiently in the production of Ordnance supplies, and its continuance is the aim of the Army Ordnance Association. By this means, and it is believed by this means alone, can the education in methods of preparedness be kept constantly before those people who, in case of sudden emergency, would naturally be called upon to furnish the soldier with his equipment.

The Honorable Benedict Crowell has called attention to the fact, and in no uncertain terms, that without previous preparation the production of fighting tools for fighting men can in no wise keep pace with the mobilization and the training of the men them-

selves. General William Crozier, for many years Chief of Ordnance, in his recently published book, "Ordnance and the World War," lays stress upon this fact, and throughout his long service in the Department he preached this sound doctrine. That his arguments fell on deaf ears is only explainable by the fact that the men to whom he appealed had, through generations of safety, become apathetic to danger.

It is impossible, and unnecessary, here to enter into a discussion of what a lack of preparative knowledge cost us during the period of the war. A single instance must suffice as a type of many. Up to April, 1917, no booster and adapter had been used in the makeup of artillery ammunition. It was a device developed in the concept of modern tools of war in Europe, and when we, in June of 1917, decided to make our ammunition interchangeable with that made under the French practice, it became necessary to develop this most important part of the modern projectile. It all looked simple enough—just a little piece of steel tube, closed at one end, a thread cut on the other, and a nut—the adapter—screwed on this, a few little additions, such as felt washers, a fuze socket, a fuze socket holder, a loading of the tube with TNT and tetryl—and there you are. Quite simple.

So this simple little problem was attacked in the best spirit in the world. Orders were given the tube manufacturer to make the booster casings. His plant was, perhaps, in Cleveland. Other orders were given to the aluminum and brass workers to make the fuze sockets. Their plants were in New England. Other orders were given to screw machine plants in Pittsburgh and Indianapolis to cut the adapter head threads. Philadelphia manufacturers made felt washers, and a plant in Worcester made the fuse socket holders. Then all these component parts were shipped to the loading plant, Morgan, New Jersey, or New Castle, Delaware, for loading and assembly.

Thus far all was well, but when the assembly began it was discovered that the slightest variation in thread cutting, the slightest off-center drawing of the metal for the fuze sockets, caused a lack of concentricity, and when the booster was screwed into the shell the whole projectile was useless for the simple reason that the fuze would be thrown off center and the entire function of the booster charge lost. Under such conditions the fuze could not detonate the booster charge, and this in turn could not set off the high explosive in the shell. The result was a "dud," and a dud is about as effective as a muzzled boy in a pie bakery.

Now no part of the procedure in this matter is open to criticism as to the ability or intention in the minds of those whose duty it was to turn out fighting tools for fighting men. The situation was due solely to a lack of knowledge, due to a lack of training and due most of all to a lack of appreciation on the part of men whose duty it had been for a hundred and thirty-five years to see that by no possibility could an alien enemy find us napping. Hard as it is to say it, it must be admitted that such a situation could not have arisen in Germany. There every shop, from the North Sea to the borders of the Near East knew how to make some well-considered part in the munitions program, and when the days of peace ended, the ways of peace ended, too, and each individual shop became overnight a cog in the great machine which we choose to call Preparedness.

The system of decentralization does not mean that the control of the guiding hand is lost. It means rather that it is strengthened ten thousand times. It can be made to mean that by the distribution of duty and education; then there is certainty of preparedness. Given ten thousand men each with a given part to play in the achievement of a given end, and they can overcome a million men possessed by scattered purpose. No one man can play all the parts in "Hamlet." Neither can a play be produced with any good effect without at least a few rehearsals, and the attempt to efficiently and promptly produce munitions of war—of even mere munitions of peaceful protection against war—without skilled men—men decentralized, but still co-ordinated—is equally futile.

As has been said, it is the avowed purpose of the Army Ordnance Association to bring about a realization of this most important factor in the preservation of peace. The Association voices the demand of American Industry to be permitted to prepare for any contingency which may arise. It proposes to act as an intermediary in the education of the manufacturer to the needs and methods of the Ordnance Department.

Every arsenal and Ordnance Depot will be made a clearing house through which the Department needs may be brought to the attention of the manufacturer, and through which the manufacturer may make known to the Department the possibilities of his plant. Eventually, then, the Chief of Ordnance will, through this system of decentralization, find himself holding the threads which tie each unit of his organization to the parallel unit in the manufacturing field. In effect he controls a dragnet covering the whole United States, and by proper manipulation he can bring instantly to his help all possible assistance in any field of endeavor. He will have the satisfaction, too, of knowing that the man at the other end of the line will be trained, specialized, and in full knowledge of Departmental needs in the activity to which he has been assigned.

In this endeavor the Association has the hearty co-

operation of the Department and the representative manufacturers; and, if the ideas and the ideals of both can be carried to a reasonable conclusion, the question of preparedness is well on the road to solution.

Controlled and co-ordinated decentralization—awkward as the phrase appears—is the solution of the problem of National preparedness. It has been the solution of many similar problems in the commercial and manufacturing world, and the furnishing of equipment to soldiers for the protection of themselves and the Nation is simply a manufacturing business. The Ordnance Department is a machine shop on a vast scale. Its uniform consists of overalls and jumpers. Its tactics are comprehended in the accurate adjustment of shell and gun and fuze and powder; of the terrifying tank and ponderous tractor; of the delicate machine gun and the lady-like Seventy-five and of a hundred thousand other tools of war.

This is a hurried and brief glance at the field of work which lies before the Ordnance Association; work which is unselfish and founded upon common sense.

[On the reorganization of the Ordnance Department on an expanded basis about January, 1918, the services of Mr. Guy E. Tripp, then Chairman of the Board of Directors of the Westinghouse Electric & Manufacturing Company, were secured for the newly organized Production Division, charged with securing the production of Ordnance and Ordnance Stores and Supplies for which orders and contracts had been placed by the Procurement Division. Under these instructions it was necessary to collect and codify all information relating to processes of manufacture and equipment and their uses for the production of Ordnance material; to make or cause to be made studies of methods, machinery and tools, so as to indicate the best methods of manufacture, the production that should be attained with various types of equipment, tools, etc., and to compile data of this character in such form as to facilitate the making of estimates of production; to be prepared to assist new manufacturers to get started, supplying them with such data concerning equipment, methods of manufacture, sources of raw material, etc., as might be necessary and to assist manufacturers already established by disseminating the results obtained in various plants manufacturing the same articles, systematically making available to all manufacturers the practice of the best with a view to enabling all to reach the highest standard with respect to quantity and quality of output.

Mr. Tripp was commissioned Colonel in the Ordnance Department on January 16, 1918, and in recognition of his excellent work as head of the Production Division was appointed Brigadier General in the Ordnance Department, United States Army, on August 23, 1918, on which date he was relieved from duty as head of the Production Division and assigned to duty as Special Assistant to the Chief of Ordnance, in charge of District Ordnance offices. The establishment of Ordnance Districts for the production of war material with a view to decentralization of authority relating to matters of administration, production, inspection and shipment of supplies was inaugurated by General Tripp during his tenure of office as Chief of the Production Division, and later played such an important part in Ordnance activities as to justify the assignment of a Special Assistant to handle matters pertaining thereto. This latter position General Tripp occupied until after the Armistice had been signed, when the condition of his company and the approaching problems of reconstruction required his return to civil life to resume his duties as chairman of the Board of Directors of the Westinghouse Electric & Manufacturing Company. The Distinguished Service Medal was awarded to General Tripp by President Wilson in 1919.—Ed.]

Notes on Ordnance and Industrial Affairs

Reasonable Preparedness.—The formation in Pittsburgh of a local branch of The Army Ordnance Association draws attention to a form of preparedness that should find general encouragement. It is designed to preserve for the War Department the knowledge acquired during the war of the manufacture of guns and munitions and to equip its members with the information necessary to enable them to serve as Ordnance Officers in case the Government should be in need of such service. There can be no doubt that the Nation would welcome their help in a crisis, for the recent hostilities demanded the employment of 7,000 Ordnance Officers, of whom all but 97 were commissioned only after the emergency arose.

The organization of the Ordnance Association is a patriotic move. Preparedness of this sort is desirable. It would be admirable if all citizens, capable of rendering special service of a technical character in time of need, would keep themselves fit for immediate response to a call.

While it is true that nothing appears on the horizon of international affairs to cause expectation of war, and there is no warrant as yet for compulsory military training or the maintenance of a huge standing army, with a caste of professional soldiers of the commissioned grade and the other evils attendant upon militarism, voluntary movements on the part of citizens for the National defense should receive all possible encouragement.—*Pittsburgh Post.*

Hammond Torpedo Control.—Some question appears to be entertained by the military and naval authorities as to the successful termination of the extensive investigation that has been made in an effort to develop the Hammond radio dynamic system of controlling the course of a torpedo or other objects in the water. Successful demonstration of the system would yield the inventor, John Hays Hammond, jr., $750,000 in accordance with an appropriation made by Congress. Difficulty has been experienced with obtaining a speed of 35 knots, which is deemed essential for the unit. Until the authorities are satisfied that this can be done, those in charge of the experiments in behalf of the government hold that no further developments can be made.

Several manufacturers have expressed confidence in their ability to produce an engine possessing those characteristics, but none of them has consented to give the guarantee, without which the War Department is not inclined to place the contract.

Payment to the inventor depends, under the law, upon a demonstration that is satisfactory to a joint Army and Navy Board, which will withhold its recommendation as to acquisition of Mr. Hammond's right until it has been announced that they are of value to the government.—*Washington Post.*

Waterproofing of Motors.—The Cadillac motor installed in the self-propelled caterpillar mount, Mark VII, for 75 mm. gun, has been provided with certain water-tight fittings for the carburetor, ignition system, exhaust, storage battery, etc., and was completely submerged while running under load for a period of approximately twenty minutes. This experiment has been repeated upon several different occasions, and it has been established that the waterproofing of a motor may be now considered an accomplished fact.—*Ordnance-Artillery Division Report.*

The Ordnance Engineer

An Appreciation

By

WILLIAM CROZIER

Charter Member A. O. A.

[The following article is a digest of a paper presented by General Crozier at the April, 1907, meeting of the American Society of Mechanical Engineers.

Over thirteen years ago General Crozier contended that the Ordnance Engineer was a constructive agent whose work was not only vitally essential to his country in the event that recourse to arms could not be avoided, but that the Ordnance Engineers of the United States Army had in the past played an indispensable part in assisting the Nation to further the cause of world civilization in making it possible for the country to fight for the right when occasion demanded it.

His analysis of the causes of our past wars and the benefits which accrued to the whole world as a result thereof finds substantial confirmation in the state of the world today.—ED.]

ENGINEERS engaged in purely civil pursuits spend their lives in an effort to improve the facilities of the world for increasing the happiness and promoting the general well-being of its inhabitants. They build great connecting links to enable people on one side of enormous obstacles to pass conveniently and safely to the other side; they provide means of wonderful efficieney whereby hundreds of thousands of people who are not where they want to be in this restless world, are transported daily with the speed of the wind to the places where they think they would rather be. They are even now emancipating these insatiable travelers from the necessity for combination, and are placing at the individual door a machine of infinite patience to wait during meal hours and sleeping time, and with no claim for consideration as to fatigue or ennui, until such time as the whim or convenience of its master may call upon it to carry him at railroad speed to any place to which other engineers may have built a practicable road.

William Crozier

Major General, United States Army, Retired. Chief of Ordnance, 1901-1918

The question arises as to whether, in all this, they are set apart from the ordnance engineer who works to create means of destruction, and whose effort is not to promote the pleasure of life but to produce means for smashing and damaging, for maiming and destroying; whose utilization retards progress in the pursuit of happiness, and necessitates a process of recuperation before its interrupted course can be pursued again from the point at which it was cut off.

It is not pleasant to say a word of discouragement to efforts for universal peace; but those efforts are not best promoted by ignoring their limitations, and by maintaining in the face of much sincere conviction that wars may soon come entirely to an end. I believe in the utility of peace conferences. I appreciate the evidence that the one of 1899 of The Hague produced an arbitration convention which has already served good purposes; and I am satisfied that it is entirely possible, and more than probable that the next conference, already arranged at that place, may improve the International Court of Arbitration so that the submission of differences to it may be more easy and inviting, and the failure to do so may be a more direct and responsible challenge to the public opinion of the world than at present. But we have only to consult history, and not very ancient history at that, to find instances of conflict in which arbitration would have been in no wise possible. The Russo-Japanese war affords an example.

When the peace conference of 1899 first assembled at The Hague, there was an effort made to induce the powers represented to make a binding agreement that they would submit certain classes of dispute to arbitration. When this effort failed there were substituted for its expression in the treaty of arbitration various forms of moral pressure, designed to promote a resort to this method of settling differences. The most pronounced of these forms of pressure was that embodied in Article 27 of the treaty, which declared that whenever two nations should be involved in a dispute which

threatened to become acute, it should be the duty of all the other signatory powers of the treaty to remind these two that the Court of Arbitration was open to them. The article was made prominent by considerable discussion before its acceptance; but no single power considered it worth while to fulfill the duty which it had engaged to perform, by reminding either Russia or Japan that the civilized world looked to them to carry their causes of disagreement before The Hague tribunal and abide by the result. It was in this case recognized that arbitration was not possible. But I think that we can find in comparatively recent history lessons which go farther than this one, and show that in certain cases arbitration is not only impossible but would be undesirable.

Our war with Spain was based upon the conceived necessity for terminating the rule of her government in Cuba; we believed that her incapacity for keeping order, for providing for the security of life and property, and for preserving livable conditions in general had been so demonstrated that it was necessary to use the land and naval forces of the United States to terminate her jurisdiction therein, and deny her further sovereignty over the island. What must have been the action of a court of arbitration upon this proposition? Courts must be guided by the law and the precedent and the established order as they exist at time of trial of the case. Our contention was to terminate the possession in which Spain was firmly established by all the rules of international law. No court, whatever its sympathies or views of the general welfare might have been, could have found justification, in any of the principles to which it would have had to look for guidance, for decreeing that Spain's lawful ownership of Cuba must come to an end against her will, and that the disposition of the island, either for annexation, autonomy or independence should be turned over to the United States. There is no process which a court could have considered by which the final result might have been brought about, against Spain's protest, except that of war. If the result was desirable, here is a case in which war served a better purpose than could have been served even by a court sympathizing with the object, but guided by its conscience and by its oath.

Nearly half a century ago the people of a part of these United States made up their minds finally that slavery was wrong, and should not be extended; the people of another section were equally positive and sincere and conscientious in their conviction that slavery was right and ought to be extended. The Supreme Court of the United States, following the Constitution and the statutes, found itself compelled to decide that slaves were property, and as such could be taken by their owners into the new territory of the United States, to be there entitled to its protection.

In the solution of this difference there was involved the question of the right of a State to withdraw from the Union. A distinguished son of Massachusetts, a veteran soldier on the Union side of the Civil War, has recently made a careful argument to show that the question of secession was not decided, was not intended to be decided and was recognized as being impossible of decision, at the time of the formation of this government. If this learned gentleman is right, and the Supreme Court of the United States was right, the settlement of one phase of the great Civil War question by judicial process must have been entirely uncertain, and the settlement of the other and morally speaking by far the more important phase, would undoubtedly by such process have been adverse to the conclusion which was finally reached, and of the righteousness and general benefit of which there is now no shadow of doubt in any portion of the entire civilized world.

In 1877 Russia went to war with Turkey in order to compel that nation to bring to an end the barbarities which were being inflicted upon the Christian people of the Balkan Provinces. In accordance with international law, Turkey was sovereign in those provinces and had the right to treat her subjects therein in accordance with the dictates of her own conscience. The war smashed this right, and brought to an end the Bulgarian atrocities, effecting the practical independence of Bulgaria. The results of the war alone would have been better than those finally secured, when a deliberative conference at Berlin partially undid the work of the sword, and left Macedonia in a subject position, to be the source of future trouble.

The American colonies went to war with the mother country in resistance to the principle of taxation without representation. During the progress of the war it became evident that harmony and satisfaction would not be restored by concession on the part of Great Britain of the main point contended for by the colonists. These concluded that nothing short of complete independence would satisfy their lofty aspirations and grant them that right of self-government in the struggle which they were ready to embark their lives, their fortunes, and their sacred honor. Great Britain was very far from being ready to consider even practical, and far less complete and theoretical independence for the colonies. She had not yet learned the lesson as to the treatment of colonies which our Revolutionary War went so far in teaching her; though she never again treated other colonial dependencies as she had attempted to treat those in America, the lesson of the war was needed to show her that it was neither right, possible nor profitable to treat colonies as regions to be drained of wealth for the benefit of the home country. The principle of taxation without representation was well established by the usage of the world; it could not be upset by any process not revolutionary in its nature, while the withdrawal of the colonies from British sovereignty was completely beyond and without the pale of all law which could be laid down and followed by any tribunal which could have been called upon to pass upon the situation. No court would have had any choice but to deny a petition for a decree of independence, if the colonists could have been wild enough to present such a petition, or could it have been possible to convene a court for receiving it. So the fathers declared that "When, in the course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth the separate and equal station to which the laws of nature and of nature's God entitle them, a decent respect for the opinions of mankind requires that they should declare the causes which impel them to the separation."

Here is the whole matter. A necessity is conceived for changing the organic law, by force if resisted, and the only obligation resting upon those who decide to take the change into their hands is that they shall have such deference to public opinion as to set forth their case to the world and appeal to the right thinking for approval of their effort. If the independence of the United States was a good principle to be secured, here again is a case where war achieved a better result than could have been accomplished by arbitration.

It seems possible that one better skilled in the study of international law might evolve an acceptable generalization from these and other instances which could be found in history, and lay down a principle that the established order, as contained in the whole body of international law and usage, and custom, being the product of human wisdom, is subject to being wrong, and to being found inapplicable to changed conditions and relations which arise in the prog-

ress of the world; that when such is found to be the case it is clear that the existing law should be changed; but that when such change is resisted by a community whose interest is supposedly or actually bound up in the wrong order, there is no judicial process by which the change can be effected; that the process must be a revolutionary one, and that resistance entails that the revolution must be brought about by force; that is, by war. And the people which has become satisfied that the change is necessary must state its case to the world, gird on the sword, and guided by its conscience and hoping for the approval of the public opinion of mankind, must resort to the only process by which that change which it believes makes for the highest good, can be accomplished.

In the cases cited in which the United States has been involved, it seems to me that thoughtful people must admit either that our country has been wrong, or that the outcome has been better than that which could have been granted by any court which it would have been possible to convene at the times when we entrusted our case to the God of Battles, in belief in the justice of whose decisions we hold up our heads to-day.

In passing their lives in the effort to improve the means for sustaining the nation's case in an appeal, in accordance with its conscience, for some great good which it is beyond the power of any court to grant, to an arbitrament of higher jurisdiction than that of any court, ordnance engineers are worthy to be classed with their professional confreres in civil life as workers for the supreme good of the human race.

The National Bureau of Standards

Notes on Its Equipment and Facilities for Testing
Compiled by the Information Section

Nearly every scientific man or engineer is more or less familiar with the work of the Bureau of Standards, but comparatively few are aware of the very broad field covered by the modern understanding of the word "standardization." This includes to-day a great deal more than work in connection with weights and measures, although this is fundamental and all else depends upon it. A great deal of the Bureau's work is of value to Ordnance officers and contractors, and it is of interest briefly to call attention to its facilities for research and testing along engineering lines.

The Bureau is composed of nine scientific divisions, each one handling some particular branch of scientific or engineering work. This grouping of the scientific staff according to the nature of the investigations on which they are engaged is a more workable plan than one based upon the different kinds of standards. We thus find that all problems dealing with the working of metals are referred to the Metallurgical Division. This division is unusually well equipped for investigations of this character and includes a completely equipped experimental foundry for the production of both non-ferrous and ferrous alloys, together with a specially designed small-size rolling mill, forging press, draw bench, etc., besides a very complete equipment for the micrographic study of metals.

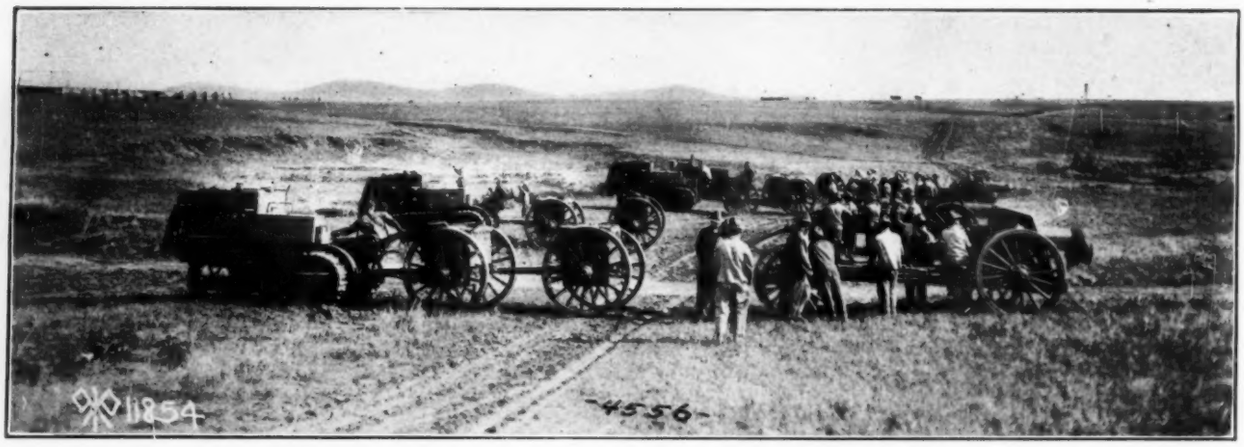
The physical testing of finished structural parts is not carried on by this division, however, but by one of the sections of the division of structural, engineering and miscellaneous materials. Here will be found a complete assortment of testing machines, ranging in capacity from 20,000 to 2,300,000 pounds, the last-named being the largest precision testing machine in the world. It was designed by Mr. A. H. Emery, of Glenbrook. It is of the horizontal type and is operated by means of oil pressure. Another machine designed also by Mr. Emery of 230,000-pound capacity is likewise provided, and is very useful for the smaller classes of very accurate work. Besides these two machines, there is a complete assortment of universal testing machines and also ones for cross-bend, fatigue and impact work.

The Chemical Division of the Bureau, among other things, acts as a distributing center for standard samples of various materials. These are of the greatest importance in the metallurgical industries and the demand for them is always great. This division, likewise, is constantly engaged upon analytical tests carried out in co-operation with the various other divisions of the Bureau devoted to the physical testing of materials.

The Bureau's facilities are, according to law, given free to the National and State Governments and under certain conditions to other institutions. It does not, of course, attempt to act as a testing laboratory for private concerns, as this class of work can best be done by commercial firms and the Bureau's facilities would be entirely inadequate. Nevertheless, routine testing of a certain kind is a very important part of the Bureau's program, and there is always a large amount under way since its laboratories are used for the acceptance testing of all Government purchases. The work done here for the military department ranks foremost among these tests. During the war, this work reached its greatest volume, but it is very large even at the present time and is so varied that the Bureau is enabled to keep in close touch with practically all present-day manufacturing and industrial processes. The variety of goods purchased by the Government can not be equaled anywhere, and for this reason any institution testing all Government purchases must necessarily be conversant with almost every class of material produced in the country. A thorough acquaintance with this class of testing work, therefore, enables the Bureau to take up most intelligently investigations along particular lines, and a large number of these are always under way for the various Government departments. It is unnecessary to call particular attention to those of fundamental importance in Ordnance work which were conducted during the war, and many of which are still in progress. They are familiar to nearly everyone engaged in this class of work.

The Bureau issues quite a large number of publications devoted to scientific work, and these are listed in a circular which is issued with supplements from time to time to keep it up to date. These papers are distributed through the Superintendent of Documents of the Government Printing Office, and engineers and others interested will secure a vast amount of valuable information by writing that office for a list of the Bureau's reports.

[Notes on Testing and other matters of interest concerning the activities of the Bureau of Standards will be a regular feature in ARMY ORDNANCE.—ED.]



Some of the earliest types of motorized artillery. Scene on the Mexican border, 1916

Motorized Artillery

By

LUCIAN B. MOODY
Charter Member A. O. A.

[Col. Lucian B. Moody, author of the following article, is the present Chief of the Tank, Trailer, and Tractor Division of the Ordnance Office. With the exception of a tour of duty as Chief Ordnance Officer of the Third Army (Army of Occupation in Germany) he has been closely identified with motorized ordnance problems since the first tentative designs were laid down in 1915.

Due very largely to the work of Colonel Moody and his volunteer associates from the Society of Automotive Engineers, it was possible for the Westervelt Board to state, after careful investigation of the status of artillery motorization in all the armies of the world, that *"the United States is far in advance of all other World Powers in respect to self-propelled vehicles applied to artillery transport."*

The benefits accruing not only to our fighting forces, but also to the manufacturers, called upon to provide them with the means wherewith to fight, are obvious. The success of the joint trusteeship plan already functioning with respect to Motorized Ordnance, clearly indicates the logical course to be followed in seeking the ultimate satisfactory solution of the entire Ordnance problem.— ED.]

THE motorization of Artillery is so recent that its history is of interest only to emphasize certain basic principles and to round out a survey of the subject. The period of the war was one of accomplishment on an enormous scale, but one now of little interest except to those immediately concerned in the work. The present is a period of vigorous development paralleling commercial development at many points, and it would seem that this is a subject in which it should be relatively easy for the Army Ordnance Association and the Ordnance Department to effectively co-operate in time of peace. This article will, therefore, touch very lightly on the past, will endeavor to give some idea of the problems of the present and will especially attempt to suggest methods of mutually beneficial co-operation for the future.

Motorized Artillery is in reality a specialized branch of combat transportation and is closely related to fighting vehicles such as tanks, and to the general transport used on the battlefield by combatant troops for such purposes as carrying ammunition, and indirectly to the Ordnance mobile repair facilities.

A clear distinction should be made between the two military motor transport problems. The first is to feed a continuous stream of supplies into the depots or dumps immediately in rear of the combatant troops, and to provide miscellaneous motor driven transportation for the service of the rear and at home. The volume of such transport is dependent on the average tonnage to be moved and the existence of roads may be assumed. In general the problem somewhat resembles commercial problems, and if the transport is in sufficient volume and properly organized, temporary delays due to storms, road repairs, etc., are permissible and should at the worst result in inconvenience rather than disaster. The vehicles for this type of transport from the earliest times have been of the prevailing peace-time types, and during the last war were largely the commercial trucks, touring cars and motorcycles of the various combatants. This type of transportation will, in the reorganized army, be handled by the Quartermaster Corps as it was before the war.

The second type is the transportation used by combatant troops during actual battle for the movement of artillery, ammunition, machine guns, bombs, trench mortars, intrenching tools, etc. No vehicle is suitable for this work that can not move with certainty over any sort of terrain, including the fording of streams

that a horse can cross, and even occasional failure is absolutely inadmissible. Another important point with this class of transportation is that the amount provided must be sufficient to move at one time the maximum amount of material that it is expected will be used until the completion of a phase of an operation permits a replenishment of the supply.

It is the second class of transport matériel that it is the duty of the Ordnance Department to provide, and quite logically so, as the relation to other Ordnance matériel is close and the Ordnance engineer fully understands the requirements. There are, of course, occasions when ordinary vehicles can perform the functions of cross-country transport, and due to the excellent roads and stabilized warfare in France there were many occasions when it actually did so. Also there are times when the ordinary motor transport is unable to fulfill its functions and must be replaced by animals or by the cross-country type of matériel herein referred to as combat transportation. However, for any operation on a large scale in the United States the normal case would prevail and the whole quota of combat transport would be required. Also sufficient roads would exist or could be constructed to permit the use of the first class of transportation on a large scale in its normal rôle.

Caterpillar mount, 75 mm. field gun, with engine running under water

It is believed that the above explains why motor vehicles were not used with Artillery until recently, and why the soldier who has depended on animal transport for his urgent needs during battle since the dawn of history, may have very conservative views regarding replacing animals for combat transport, and he is certainly correct unless the substitute can do everything that the horse has been able to do in the past. Assuming this one vital condition to be met, every other consideration is most decidedly in favor of the motor. It is cheaper to operate, the volume and tonnage of fuel and oil is less than that of forage, it does not eat when not working, requires less men and less training of these men, it is easier to transport by rail or water, requires less space on the road, is not subject to fatigue, is less vulnerable to gas, bombs and enemy fire, does not create the unsanitary conditions that the horse does alive or dead, and is easier to camouflage; but it must be repeated that all these advantages are negligible in war unless the motor combat transport can do as well as the horse in getting matériel to the place where needed at the time needed.

Fortunately, the United States had made such experiments before the war as the limited funds permitted, including the actual motorization of first a battery and then a regiment of Artillery with the best motor matériel then available, and a group of Artillery and Ordnance officers had formed views so sound that they were used as basic principles in providing artillery transport for the war. A bit of war history in this connection is that before the war was two weeks old the Ordnance Department had recommended that a board of Artillery and Ordnance officers and the President of the Society of Automotive Engineers be convened to report on all questions relating to Artillery motorization, and from that board can be traced the smooth working Ordnance Committee of the present day, co-operating officially, through the Technical Staff of the Ordnance Department, with the Ordnance Advisory Committee of the S. A. E., and the pleasant and valuable personal relations between the members of the Advisory Committee and the officers of the Army actively engaged in solving the problems of the present.

As a rule wars are fought with the types of matériel that have been fully developed in times of peace except that in a war of the length of the recent one certain urgently needed matériel may be brought to a more or less satisfactory state of perfection during the war. This war was no exception to this rule, and the duty of each military establishment at the present time is to perfect for a possible future emergency the types of matériel that the war has in its opinion shown to be essential for the equipment of its troops. In the case of the United States Artillery, a board was convened shortly after the armistice for the purpose of making a study of the types and calibers of Artillery required for a field army and the types of transportation therefor. This board is popularly known as

From Detroit to Germany. Quantity production of five-ton tractors

the *"Westervelt" or "Caliber" board, and its report, approved by the War Department in June, 1919, is the guide for the development work now in progress.

The report, while conservative and well thought out, nevertheless requires practically a complete redesign of every type of artillery and improved transportation therefor. Those to whom this may seem radical should bear in mind the previous statement that wars are fought with matériel developed before the war; for example, the French "75" is Model 1897 and the best rifle used was admittedly the American Model 1903; *i. e.*, the designer of war material must look far ahead so that when an emergency arises the material he has designed will not be found wanting.

The Westervelt Board roughly covers divisional, corps and army artillery and special artillery, such as railway mounts and artillery to be carried on pack animals.

The first three classes are the most important from the standpoint of this discussion as they are certain to be in the equipment of any army unless some discovery as revolutionary as the invention of gun powder should completely modify the present methods of warfare.

Divisional Artillery consists of a field gun of about 3-inch bore and a howitzer of about the weight of the gun but throwing a heavier projectile. The objective of these weapons is primarily the Infantry of the enemy, and the weight of the pieces, ready for firing, should not greatly exceed 3,500 pounds, and limbered up ready for towing should not exceed 5,000 or 6,000 pounds.

Corps Artillery consists of a gun of about 4.7-inch caliber and a howitzer of about 6-inch caliber, intended for the destruction of the Divisional Artillery of the enemy, the breaking down of strong points and firing on roads, dumps, troop concentrations, etc., that are within their range. These pieces, ready for towing, would weigh approximately 14,000 pounds.

Army Artillery consists of guns of about 6-inch caliber and howitzers of about 8-inch. The weight of

*A full discussion of the work of this board in establishing basic requirements for our future Artillery development program is now under preparation by its President, Brig. Gen. W. I. Westervelt. It will be printed in an early number.

each, ready for towing, would be approximately 25,000 pounds. The mission of these guns is to bring a destructive fire at long range upon any suitable objectives, such as enemy Artillery, rail heads, ammunition dumps and roads beyond the range power of the other Artillery.

The present approved method of moving this Artillery is by towing with tractors, and the method of moving ammunition therefor is by towing caterpillar trailers with the same type of tractors that pull the guns. In addition experimental development is strongly recommended for guns mounted on caterpillar vehicles with the power plant incorporated therein; *i. e.*, a self-propelled mount. The experimental development is also being pushed of caterpillar type cargo carrying vehicles for carrying ammunition, etc., in the battle area.

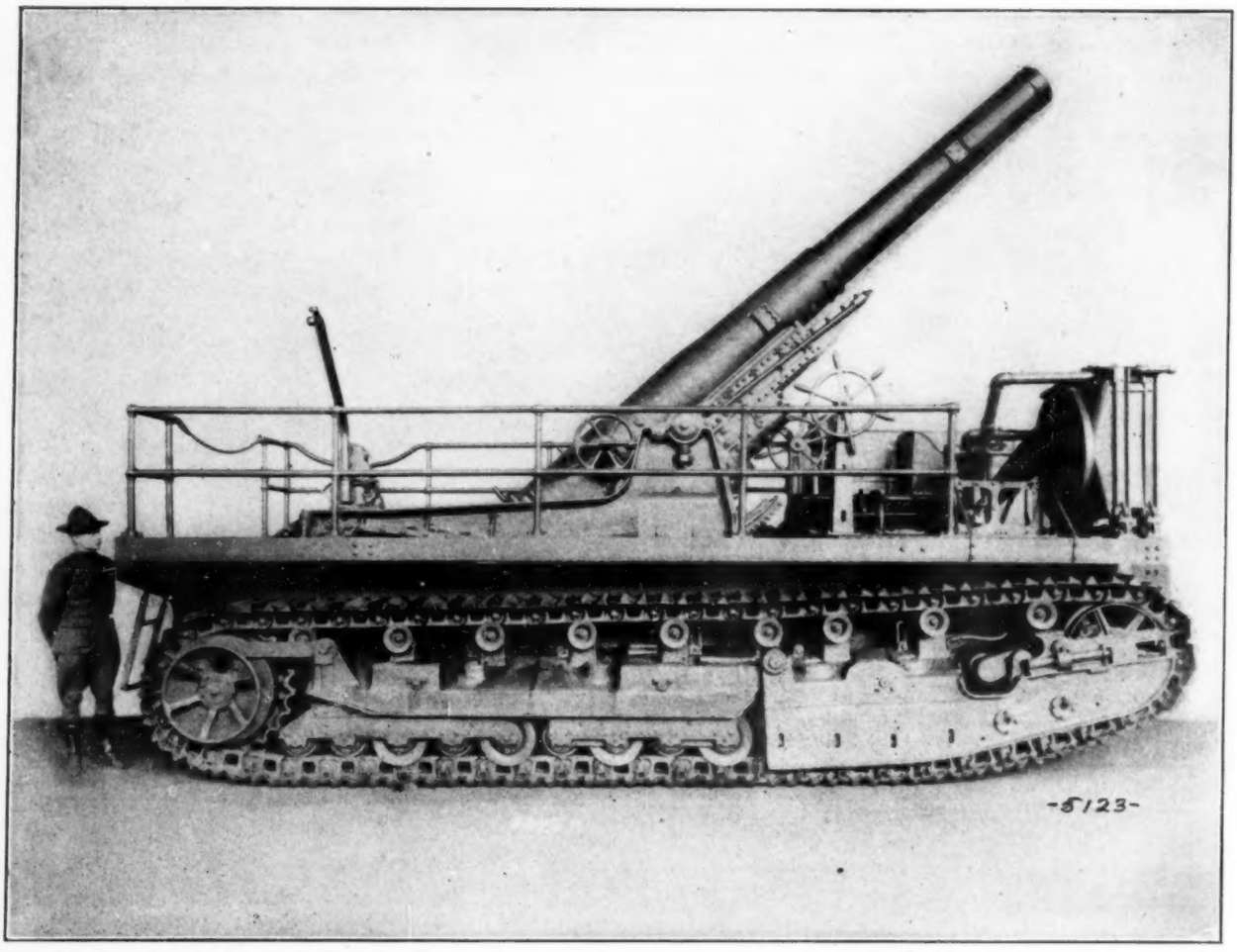
The advantages of the tractor-drawn system are that the tractor is less specialized than the self-propelled mount, and if necessary available tractors of even inferior type can be used in emergency, the weight of the individual vehicles is less, the power plant is not exposed to fire and may be used for other purposes when the gun is in action, and the type of vehicle used for moving the gun is the same as the type of vehicle used for moving the supplies.

The advantages of the vehicle with self-contained power plant are that less road space is required, short changes of position may be made without bringing up a tractor, and in general maneuvering is somewhat easier.

The tractor-drawn system has the advantage of having stood the test of actual war, but it is believed that only experimental experience with both the tractor-drawn system and the self-propelled system will definitely determine the best type to be used from a tactical standpoint, and it is possible that there may be a place for both types.

While the one essential condition for any type is to be able to cross the terrain of the battlefield, this war has demonstrated the extreme desirability of being able to move an entire division at high speed from one point to another, and of being able to strike a blow as a complete division upon arrival at the new point of attack. During the past war this was not possible, for while the Infantry might be loaded on trucks the Artillery and much of the combat transport was horsed or drawn by slow-speed tractors, which meant

Motorized artillery of the Third United States Army in Germany



A motorized 240 mm. howitzer. Note the comparison of size with that of the soldier

that a division could not be moved as a unit except by marching or by transporting by rail.

This new demand requires that the vehicles used for transporting the Artillery, as well as the guns themselves, should be capable of sustaining speeds of the conventional motor truck for long distances, which is an extremely hard condition to meet with vehicles having the ruggedness and power to move over the terrain of the battlefield. The only system possessing certainty of movement on bad terrain is the caterpillar, which is not an ideal from the standpoint of speed. It is necessary to either develop the caterpillar type of vehicle so that it will be capable of the speed of the ordinary truck or to use a more complicated type of vehicle which will run on wheels wherever the conditions are sufficiently good to permit the use of trucks and as a caterpillar when it is desired to operate off the roads.

To meet the requirements outlined above the following vehicles are now being actively developed; suitable tractors, each of approximately the weight of the gun, for Divisional Corps and Army Artillery; a caterpillar trailer of about 1½-tons capacity suitable for use with Divisional Artillery, and a trailer of about 3-tons capacity for use with Corps and Army Artillery, a cargo-carrying caterpillar with self-contained power plant of about 1½-tons capacity for use with Divisional Artillery, and one of about 3-tons capacity for use with Corps and Army Artillery; experimental self-propelled gun mounts for Divisional Corps and Army Artillery of the calibers mentioned above; and a number of very small cross-country vehicles for carrying the machine guns, etc., of the Infantry.

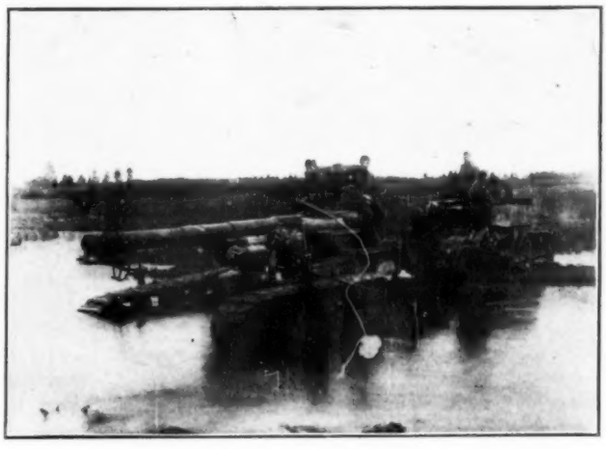
The engines and power plants of caterpillar-type vehicles are being laid out so as to be capable of speeds of at least 15 miles per hour, so that even though the caterpillar-track mechanisms at present available may not be capable of standing this sustained speed that it will not be necessary to completely redesign the vehicles when the better track mechanisms are developed, but merely to change the design of track, which is a comparatively simple matter.

It is hoped that the above gives some idea of the great amount of design work and experimental construction which must be carried out under rather

difficult conditions as to personnel and facilities, and it is thought that the methods being used may be of more interest than the technical details of the various vehicles, and may also indicate a way for co-operation between the Army Ordnance Association and the Ordnance Department in other lines of Ordnance work in which the problems of the commercial manufacturer and the Ordnance Department are not as nearly related as they are in the case of motor vehicles.

To begin with, it is definitely recognized that commercial matériel, such as engines, and, if possible, complete vehicles, must be used wherever possible, and if this is not possible that special components should be made to commercial specifications in order that quick production may be assured.

The general requirements for the matériel is laid



Showing type of country motorized artillery must cross. A ten-ton tractor towing a 155 mm. gun

out by the War Department in broad terms, and, as previously stated, practically all work now in progress is based on the Westervelt Board Report.

The Ordnance Department is then confronted with the problem of satisfying two groups of people whose interests are conflicting: First, the matériel must be satisfactory in design, endurance, etc., to the combatant troops that are going to use it; and, second, it must be satisfactory from a production standpoint to the manufacturers who would be required to build the matériel in time of war.

At present the amount of actual design work that can be obtained from commercial agencies is practically negligible on account of everyone being busy readjusting his own business to a peace basis, and to accomplish the actual work of design engineering offices in addition to the Washington office have been established in Peoria, Detroit, Cleveland and Syracuse, which are in charge of Maj. H. K. Sheridan, Mr. D. M. Ferguson, Capt. G. R. Pennington and Col. A. M. Chase, respectively. These offices being more or less in the heart of the automotive industry draw their subordinate designers and draftsmen from people who are familiar with commercial practice, which tends to insure satisfactory designs from the production standpoint.

In starting work on a given problem, general specifications, which are not sufficiently detailed to control the design, but which will hold it within reasonable limits, are prepared and submitted to the Ordnance Committee, which is an advisory body to the Chief of Ordnance, consisting of representatives from each of the combatant branches and officers of the Ordnance Department. These specifications are also submitted to the Ordnance Advisory Committee of the Society of Automotive Engineers, with a view of obtaining the criticism of this Committee, which at the present time has the following members: Mr. J. G. Vincent, Lt. Col. H. W. Alden, Mr. George W. Dunham, Mr. Charles M. Manley, Capt. Dent Parrett, Lt. Col. William G. Wall, Mr. Charles W. Kittering and Mr. C. F. Clarkson.

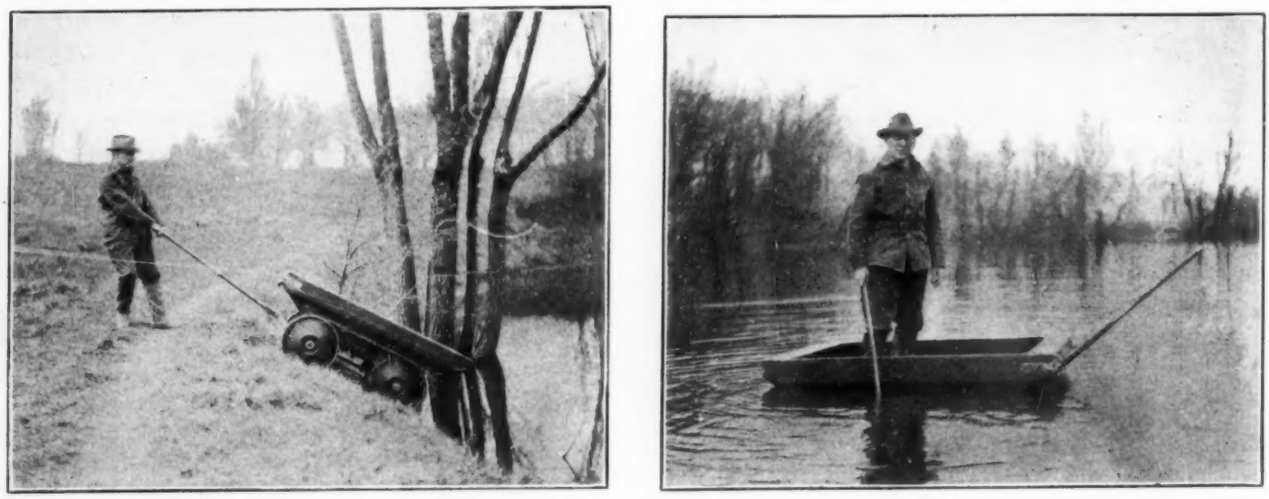
As the design and construction of the experimental vehicle proceeds drawings, models or sample vehicles are submitted, at proper times, to the Ordnance Committee and the Advisory Committee of the S. A. E. with a view of obtaining more detailed criticism of the proposed construction.

The result is that a vehicle going into service has the stamp of approval of the War Department, of the user, of the producer and of the designer before being actually put in service, and there is absolutely no question but what the methods now being used are by far the happiest, and should produce the best results of any that have heretofore been tried.

It will, however, be noted that excellent as these methods are, the Army Ordnance Association as such is not used in any way, although its individual members may be in touch with what is going on, and some of them are actually members of the Advisory Committee.

Shortly after the inception of the Ordnance Association the writer made a strong recommendation as an individual to the Acting Secretary of the Association to the effect that there should be organized within the Association an automotive branch which would permit of keeping the members of the Association interested in automotive matters directly in touch with the people in the Ordnance Department interested in such matters, and it was with considerable pleasure that I recently noted that the Committee on Aims and Organization, of which Colonel Spruance is chairman, had proposed a subjective organization of the Ordnance Association which would assign to the individual members of the Association the special work of keeping in touch with the Ordnance subjects in which they are especially interested. The work of Ordnance is so varied that a man devoting a lifetime

to the work has not more than a superficial knowledge of many of the subjects included in Ordnance, and for anyone in civil life already fully burdened with troubles of his own to have a knowledge of all branches of Ordnance is impossible. There are, however, certainly many members of the Association who either through patriotic motives or merely to cultivate a hobby should be glad to keep in touch with some selected subject, and perhaps to use this means of keeping up some of their war-time associations.



Two views showing the adaptability of the new caterpillar

New National Hydraulic Laboratory Proposed in Buenos Aires.—According to Trade Commissioner Brady the Argentine National University at La Plata has petitioned for a hydraulic laboratory to be used in experimental work by the engineering students. Already the Minister of Public Works has reported favorably on the project and has asked that a piece of land 975 feet by 1,625 feet, in the Buenos Aires port between the East Canal and the Port Railway, be allotted for the construction of the laboratory. Final approval of the project will rest with the Argentine Congress at its next session in May. Efforts of American manufacturers in the past to introduce laboratory apparatus and machinery into the colleges of Argentina have not equaled those of their European competitors. Now an opportunity is offered them through the construction of this national hydraulic laboratory to place their equipment before prospective Argentine engineers.—*Chemical and Metallurgical Engineering.*

Improvements in Projectiles.—As a result of improvements made in the process of manufacturing high-explosive shells and of slight changes in the shape, the army has succeeded in obtaining projectiles that will go through armor plate with less injury to themselves and with greater bursting and destructive power after reaching the interior of a ship than heretofore.

This was demonstrated by tests recently held at the proving ground at Aberdeen, Md. A 14-inch projectile was fired at an armor plate 14 inches thick. When the firing was so that the projectile struck the plate at an angle of 10 degrees from normal (from perpendicular), it passed through unimpaired, and it is understood that that is the first time that has been done. When the projectile struck the plate at an angle of 20 degrees from normal and passed therethrough, it was found to be in good condition, except for slight deformation of the base and a small crack to the cavity, which might slightly lessen, but not materially interfere with, the destructive effect on detonation of the bursting charge inside of a ship.—*Washington Post.*

Low-Temperature Laboratory Established.—A cryogenic laboratory is to be established at once in Washington in connection with the helium work being done by the Bureau of Mines. The necessary funds for equipping the laboratory and conducting the work are being allotted to the Bureau of Mines from appropriations made to the Army and Navy Departments. The work in this new laboratory will be directed by R. B. Moore, the chief chemist of the Bureau of Mines.

Ordnance District Office Changes.—The St. Louis District Ordnance Office has been discontinued as such, and the salvage, property and other necessary activities pertaining thereto transferred to the Chicago District Ordnance Office, with headquarters at the Chicago Storage Depot.

The Chairman of the Chicago District Salvage Board has been appointed Commanding Officer of the former St. Louis Ordnance District, but such of the Claims Board personnel and cost accountants as may be considered necessary will remain in St. Louis Office.

Report of Screw Thread Commission.—The National Screw Thread Commission, which was created by Act of Congress (H. R. 10852) approved July 18, 1918, has completed its reports which have been signed by three Secretaries. Orders are now in the Government Printing Office for 1,000 copies of each report. These are to be issued through the commissioners—Maj. J. O. Johnson, Chief of Gauge Section, is the Ordnance representative, as is also Col. E. C. Peck, now general superintendent of the Cleveland Twist Drill Company, Cleveland, Ohio.

Commercial Possibilities of Government Nitrate Plants

By

JAMES H. BURNS
Charter Member A. O. A.

[Col. James H. Burns, author of the following article, is Chief of the Nitrate Division, Office of the Chief of Ordnance, United States Army, and a recognized authority on matters pertaining to the development of our nitrate resources.
His able exposition of our present situation in this regard is not only of interest to all patriotic Americans who are to-day giving thought to our future military security, but is also of immediate and vital importance to those engaged commercially in the production of artificial refrigeration, to our fast-expanding chemical industries, and to our agricultural interests in general.—Ed.]

WAR is by its very nature destructive in purpose; while Peace, on the other hand, is in general constructive. The one is devoted to the utilization of all the forces of a nation for the infliction of the maximum injury to the enemy; while the other lends its efforts to the most efficient harnessing of the resources of a country for the pleasure of all mankind. As a result of these diametrically opposed objects, very few of our military preparedness efforts and war-time accomplishments fit into the peace-time commercial pursuits of a nation. There are, of course, exceptions, and one of the most important of these is the World War development for the fixation of atmospheric nitrogen, created for the purpose of supplying us with basic nitrogen compounds.

While fixed nitrogen in one form or another is indispensable to a nation at war, it is equally important to the nation at peace; and in the present state of civilization, it is true that no nation can become or remain great either in peace or war that is not provided with an ample supply thereof.

It will be the effort of this article to describe briefly the kinds, uses, and sources of nitrogen compounds, to summarize the Government developments in Nitrogen Fixation, to show the logic of utilizing them for commercial purposes during peace, and, finally, to outline the scheme recommended by the War Department for the solution of the problem.

Kinds of Nitrogen Compounds

All basic nitrogen compounds belong in general to one of two families; namely, nitrate compounds or ammonia compounds. In addition chemical art has the necessary knowledge to convert ammonia compounds into nitrate compounds. The conversion causes the loss of some 10 to 15 per cent of the nitrogen content. The ability to convert a nitrate into ammonia has not yet been developed.

Uses of Nitrogen Compounds

The uses of nitrogen compounds can be subdivided into two main classes—Munitions and Commercial.

Munitions. From a military standpoint only, it is difficult to exaggerate the importance of nitrogen compounds. We all know that powder and explosives are in reality the heart of munitions, for, in practically all types of Ordnance matériel, they furnish the real force that is turned loose against the enemy. No gun can be fired without powder, nor can any shell, bomb, or torpedo be exploded without explosives. And in no case can powder or explosives be manufactured without the use of a nitrogen compound. This latter material is in fact the substance which converts the many harmless bases, such as cotton, glycerine, toluol, etc., into powder or explosive, or nitrocellulose, nitroglycerine or dynamite, trinitrotoluol or T. N. T., etc.

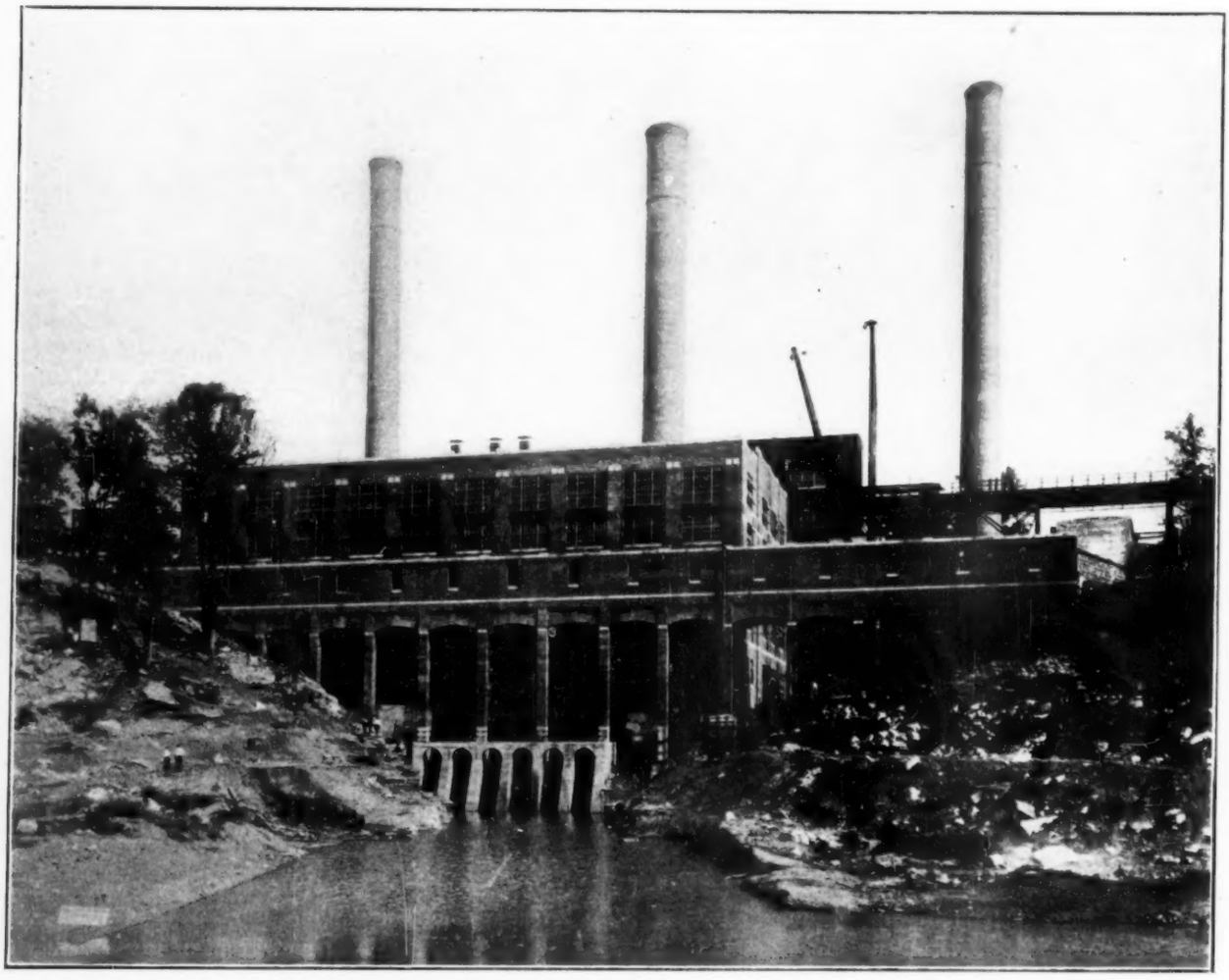
In time of war the consumption of these materials for strictly military purpose is, of course, tremendous, and in the last war far exceeded all expectations. In any large war of the future the use thereof will undoubtedly greatly surpass their use in this war, for as time goes on the real strength of an army is more and more dependent upon its chemical munitions. In this connection it is interesting to note that one Division in the World War consumed per year over ten times as much fixed nitrogen in the form of powder and explosives as the entire French Army during an equal period of the Napoleonic Wars.

Commercial. The demand for fixed nitrogen for commercial pursuits can be divided into three classes; namely, Fertilizers, The Chemical Industry and Refrigeration.

Fertilizers. They have, of course, since the earliest days of human history been used in the growing of plants. In the first instance they consisted in placing back on the farms the droppings of animals as well as the remains of crops. As chemical development has progressed, however, study has been made of just what elements are needed and in what form they should be used to sustain plant life. As a result of this, knowledge has been gained as to the inorganic or mineral materials that can be used to augment as fertilizers the organic substances previously used. And this study and development has clearly shown that

one of the most important of these substances is fixed nitrogen either in the form of a nitrate or as ammonia. The growth of the use of inorganic fertilizers has been remarkably rapid. The first use occurred in the United States about 1880. To-day some 8,000,000 tons

We all know of the field of domestic explosives, how they are being used in constantly increasing quantities to mine metal ores, coal, rock, etc., to displace human labor in the excavation of ditches and foundations, in the planting and cutting of trees, etc.



Power house at U. S. Nitrate Plant No. 2, Muscle Shoals, Alabama. Capacity, 60,000 KW. Note comparative size of man in foreground

are used annually with a present-day value of approximately $400,000,000, and of this amount some 100,000 tons are fixed nitrogen with a value of approximately $40,000,000.

The future is sure to show a greater consumption. A constantly increasing percentage of our population is living in cities and purchasing their foodstuffs rather than raising them. In addition the natural deposits of plant food in our soils are constantly decreasing. The production of inorganic fertilizers is therefore of basic importance to this country.

The Chemical Industry. Fixed Nitrogen is vital to that part of chemical industry consisting essentially of domestic explosives, dyes, artificial leather, photographic films, celluloid, and other products of nitrated cotton.

The manufacture of dyes, artificial leather, films, etc., is very much of an infant industry in the United States. It is, of course, rapidly growing.

It is important to note that this entire chemical field is the product of knowledge which allows us to nitrate certain bases by the use of nitric acid—a knowledge which had its start only some 40 years ago. Its growth has been so rapid that approximately 100,000 tons of fixed nitrogen are consumed annually therein.

Refrigeration. Practically all refrigeration plants in this country require ammonia for their operation. In this field again the growth is very rapid. We all know from personal experience of the ever-increasing dependence of the country on refrigeration to preserve foodstuffs, and on "artificial ice plants."

In general it is the experience of the world that the use of inorganic nitrogen compounds doubles every ten years.

Sources of Nitrogen Compounds

These are three—The Nitrate Beds of Chile, By-Product Coke Ovens, and Atmospheric Nitrogen.

Nitrate Beds of Chile. These are natural deposits of sodium nitrate which have been practically supplying the world with nitrate nitrogen from their discovery to the present time. They, of course, did not supply Germany and her Allies during the World War. It seems to be the consensus of opinion that while these deposits are of large proportions, they are far from being unlimited in extent. Their remaining life is estimated at varying lengths—from 40 to over 200 years. In addition to this, it must be remembered that Chile is a foreign country, and in time of war an uncertain source of supply.

By-Product Coke Ovens. At present these are the only source of inorganic nitrogen in the United States.

In the distillation of bituminous coal for the production of coke, ammonia gas is driven off as a by-product along with other gases, including toluol, benzol, tar, etc. In the earlier days the coking of coal was all done in "bee-hive" ovens, and all of these valuable by-products were lost. Some 30 years ago, the by-product oven was invented which captures these materials. The installation of this latter oven has fortunately increased rapidly until to-day nearly 60 per cent of all coke is produced therein, and it is to be hoped that this program will continue to the maximum limit.

It would be ideal if we could supply our full needs for nitrogen from this source, but unfortunately such a solution is not possible. Even though all the coke were produced in by-product ovens, the supply of nitrogen would not be adequate even for peace-time purposes, and our studies are to the effect that for several reasons it will not be economical to try to produce in excess of 70 to 75 per cent of our coke in such ovens.

Atmospheric Nitrogen. Chemists have long recognized the atmosphere, of which four-fifths are nitrogen, as the huge and unlimited reservoir that must ultimately be relied upon to supply our needs in the way of fixed nitrogen compounds. The very aloofness of nitrogen, or its refusal to combine or stay combined with other elements which gives it so much value in explosives, on the other hand causes tremendous difficulty in harnessing it. Its fixation by chemical or electro-chemical means has, however, been developed in recent years, and several methods are in active operation. In all cases, it is necessary to force the combination of nitrogen with some other material. The combined nitrogen can then be manipulated chemically so as to produce the desired material.

There are three principal processes which in very general terms are as follows: The Arc, in which the nitrogen and oxygen of the air are combined to form nitric oxide which is then converted into nitric acid and nitrates; the Haber, in which the nitrogen of the air is combined with hydrogen from water gas to form ammonia; and the Cyanamid, in which atmospheric nitrogen is combined with calcium carbide to form lime nitrogen or cyanamid. Nitrogen in this form can then be converted into ammonia. Ammonia can be converted into nitric acid and nitrates.

Of these, the Arc requires very large quantities of electric power and can therefore be commercial only with cheap water power. Its principal development is in Norway. The Haber method is a very intricate chemical and mechanical process, and to date has only been worked out satisfactorily by Germany. The cyanamid is in general use throughout the world.

There is one small arc process plant near the west coast of the United States. Otherwise there are no fixation plants within our borders except the Government plants.

Government Developments in Nitrogen Fixation

Prior to the World War, and in fact even to the present day, practically every pound of powder and explosives made in the United States has been dependent upon Chilean nitrate. The only exception of note is the ammonium nitrate produced at the Muscle Shoals Plant. Even to-day with our tremendous developments of by-product coke ovens we are, for all purposes, less than 50 per cent independent of importations of fixed nitrogen, and during and preceding the war this independence was less than 25 per cent. This condition from a military standpoint would be practically suicidal, unless adequate steps were taken to augment the supply in case of need.

The higher authorities appreciated this, and in 1916 Congress appropriated $20,000,000 for the development of processes of nitrogen fixation, the utilization of the products for military and industrial purposes, and the harnessing of water power to furnish the necessary energy.

This gave the country its start in nitrogen fixation, and as a result of this legislation and after considerable study, the No. 1 Nitrate Plant at Sheffield, Alabama, was started for the production of ammonia by a modification of the Haber Process. The plant also includes facilities for converting the ammonia into nitric acid, for concentrating nitric acid, and for the manufacture of ammonium nitrate. Operation has proven the success of these latter facilities, but it has also proven that the ammonia process arrangements

Catalizer Building at U. S. Nitrate Plant No.2, Muscle Shoals, Ala., where nitrogen in the form of ammonia is converted into nitric acid

were not satisfactory. The War Department is at present endeavoring through research and engineering studies to correct the troubles, and strong hope is felt that the efforts will be successful. Its development must of necessity, however, be slow, and no appreciable quantity of product can be expected therefrom for some time.

As a further result of this legislation there is in the building at Muscle Shoals, Alabama, one of the largest dams in the world which it is expected will develop a maximum horsepower of 375,000. The expected minimum due to low water will be 100,000, and the average for the year is estimated at 300,000.

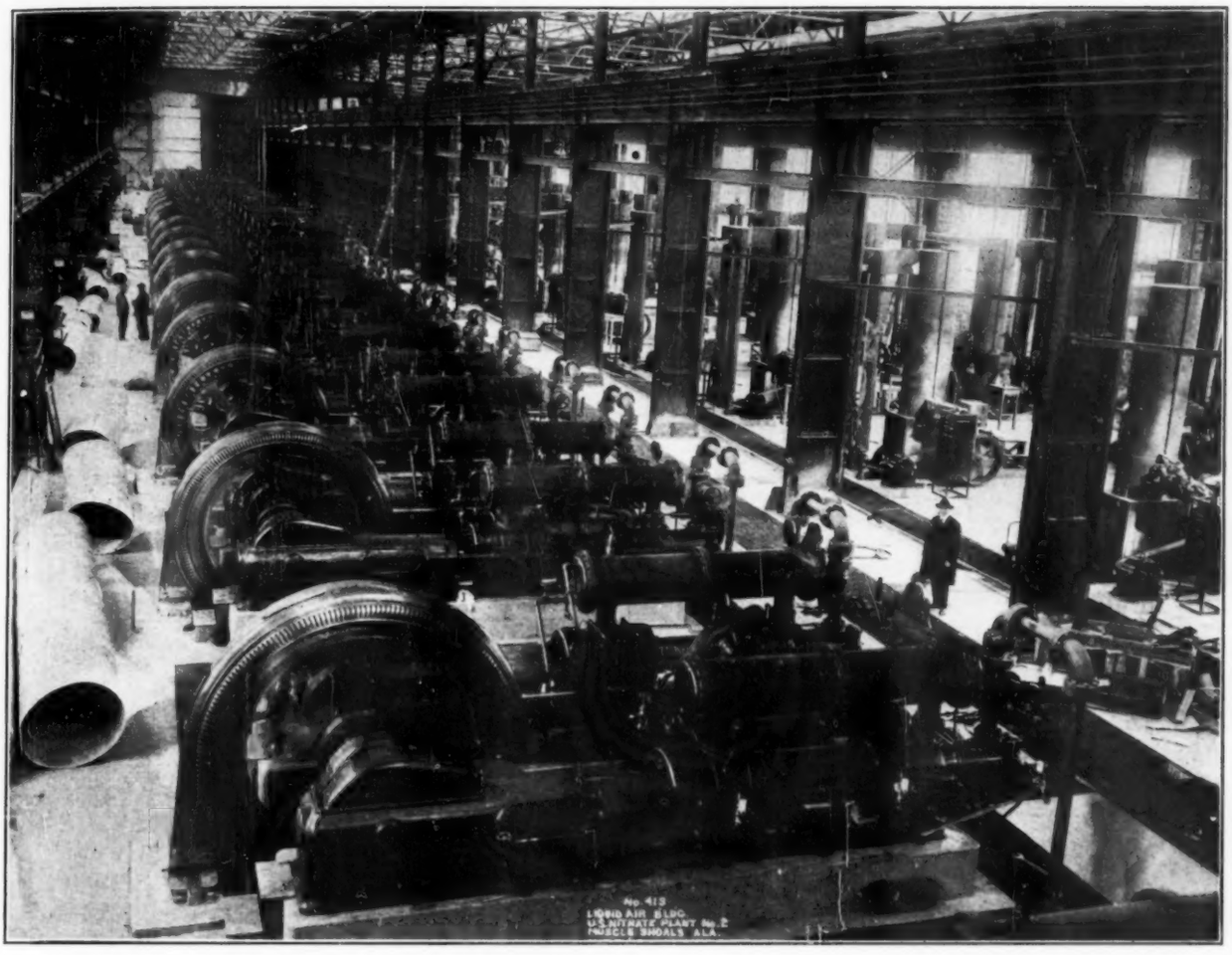
The developments of the war convinced the higher authorities of the necessity of additional arrangements for the fixation of atmospheric nitrogen, and as a result nitrate plants 2, 3, and 4 were started. The latter two were not completed due to the Armistice and were salvaged, but No. 2 was completed and given a sufficient test run to insure its practically complete satisfactoriness. It is probably the largest nitrogen fixation plant in the world; is well designed and of permanent construction. It is undoubtedly a plant that the country can well be proud of. Its situation is ideal, in close proximity to all its essential raw materials and in the heart of the fertilizer consuming region.

It fixes nitrogen by the cyanamid process, converts all of this material into ammonia, and by oxidizing part of the ammonia into nitric acid finally produces ammonium nitrate. It has a capacity of approximately 45,000 tons of ammonia nitrogen per year and can convert approximately half of this into nitrate nitrogen.

As a result of the War, the Government, therefore, finds itself with the No. 1 Plant which is not yet fully developed, with the completed No. 2 Plant and with the Wilson Dam in the building. The primary power of this dam is just sufficient in quantity to operate the No. 2 Plant, and the cheap water power is necessary for its economical operation, inasmuch as the most expensive element of its cost is power.

Reasons for Utilizing Government Plants for Commercial Purposes during Peace

As a further result of the War, the Government is more fully convinced than ever before that an ample domestic supply of nitrogen compounds is essential to



Liquid Air Building at U. S. Nitrate Plant No. 2, Muscle Shoals, Ala. Here, by liquid air process, the nitrogen of the air is separated from the oxygen of the air

its safe future. It believes that this domestic supply is dependent both upon by-product coke ovens and the fixation of atmospheric nitrogen. The solution requires therefore the ability to obtain the nitrogen compounds from both sources and to convert the same into the various usable forms.

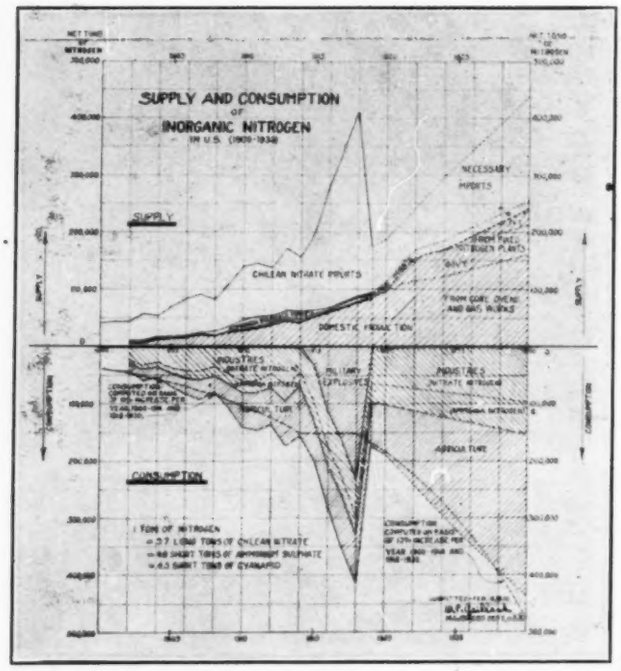
Happily the By-Product Coke Oven industry is well established in the United States. But such is not the case with the fixation of atmospheric nitrogen. Outside of the Government plants there is practically no development in the United States; and it is quite manifest that "ability" to fix nitrogen and convert it into usable forms requires an operating organization and a going plant. Nothing less will give the country the necessary knowledge to expand or multiply its facilities in time of need to keep pace with demand.

The obvious deduction from a military standpoint is therefore that both nitrate plants should be developed and operated.

But during peace the army has use for only a negligible quantity of their product. The question at once arises, Can the commercial markets absorb the products? The answer is dependent upon Price and Supply and Demand. We have made quite careful and thorough analysis of the costs of producing nitrogen compounds at the No. 2 Plant, and as a result thereof we believe that the materials can be produced at a price that should be satisfactory to both the Government and the consumer. We have also inquired in detail into the quantities produced and consumed over a long period of time from the various sources and in the various uses that we have already described, and it is our judgment that the market can easily absorb the products without appreciably interfering with present sources. Today, the farmer is paying more for his nitrogen than ever before, but is having great difficulty in obtaining the necessary quantities. There is similarly a most serious shortage in ammonia for refrigeration even at excessive costs. The complete round-up of this study is included in the curves of the chart published herewith. (See page 20.) It seems clear, therefore, that the plants have very favorable commercial possibilities.

Scheme Outlined by War Department for the Solution of the Problem

It is believed that it is the general policy of the Ordnance Department to obtain ample military pre-



paredness at minimum cost to the United States and with maximum dependence upon industrial efforts. In other words, the Ordnance Department, while standing strongly at all times for munitions preparedness, believes that the cheapest and best preparedness is through industrial development. As has already been pointed out it believes that in this particular instance it must have a permanent operating fixation plant to insure preparedness. Private industry of itself can not yet guarantee such a solution. The Government is therefore faced with three possible courses if it would accomplish its purposes:

1. To sell the Plants to Private Industry under proper guarantees.

2. To Lease the Plants to Private Industry under proper guarantees.

3. To Operate the Plants by the Government.

Government representatives have endeavored to make satisfactory arrangements through both the selling and leasing schemes but without success. The Government is, therefore, practically forced to adopt the third scheme or to operate the plants itself.

It realized that this is essentially a commercial undertaking and that, therefore, it should be handled along business lines. Accordingly, it recommended that the Government nitrogen fixation activities be turned over to the United States Fixed Nitrogen Corporation—all stock of which was to be owned by the Government. The Corporation would have authority to do business in accordance with commercial practice; but in order to insure that Government policy was properly pursued, the directors were to be appointed by the Secretary of War.

The corporation would have the task of operating and developing the Government fixation plants for the production of nitrogen compounds for agricultural and industrial purposes during peace, which would in turn with practically no modification keep them ready to turn out nitrogen products for military purposes in time of need.

The Corporation would require a capital of $12,500,000, but this was to be raised by the sale of some 150,000 long tons of the war reserve of sodium nitrate, and would therefore require no appropriation by Congress. This reduction in stocks was possible as it was felt that the operation of the plants would give preparedness at least equal thereto. This capital was considered sufficient to not only put the Corporation on a self-sustaining basis but also to make to the Government an annual return of some $3,000,000.

A bill to this effect was introduced at the last session of Congress and was favorably reported out by the Agricultural Committee of the Senate. No action

Ammonium nitrate building at U. S. Nitrate Plant No. 2, Muscle Shoals, Ala., where the product of ammonia-nitric acid is grained for shipment

Lime nitrogen building at U. S. Nitrate Plant No. 2, Muscle Shoals, Ala., where nitrogen gas and calcium carbide are combined to form lime nitrogen or cyanide

was taken by the Senate itself nor by the House or the House Military Affairs Committee to which it was referred.

[In order that the bill creating the United States Fixed Nitrogen Corporation might enjoy the prestige of a position on the calendar it was reported favorably to the Senate just prior to adjournment. The original bill was changed in only one particular. Where it provided for the payment of the common stock subscription of $12,500,000 from the Treasury, the committee amended the bill as follows:

In order to pay such subscription, as and when called, the Secretary of War is hereby authorized to sell so much as may be necessary of the supply of nitrate of soda owned by the United States and held as a reserve by the War Department, at such prices and under such regulations as may be prescribed by the Secretary of War. All sums realized from such sale are hereby appropriated to the use of the Secretary of War for the purchase of the preferred stock of the corporation.—Ed.]

Notes of Association Interest

Tank Telephones.—To provide for better communication between the different members of the tank crew, tests have been made preliminary to installing these telephones in the Mark VIII tanks, and installation has been approved by the Technical Staff. Complete sets of the apparatus are being purchased from the Klaxon Company and from the Callophone Company, and, after installation and criticism, competitive bids will be called for.

Steam as Motive Power for Artillery Automotive Vehicles.—The sub-committee considering the recommendations of the Ordnance Advisory Committee that the Ordnance Department make a study of steam as a motive power for artillery vehicles, finds but little data available on this subject and recommends that it be allowed further time to collect data and prepare a report and recommendation.

Aircraft Armament Board.—The board appointed some time ago to meet at Washington in the office of the Army Chief of Ordnance to consider development of aircraft machine guns and cannon, completed its work with a report on cannon. A report on machine guns was submitted some time ago. A study was made of different types of machine guns and cannon for use in aircraft, and recommendations were made as to the types of such pieces and ammunition therefor that should be developed. The board consisted of Col. Thomas D. Milling, Air Service; Lieut. Cols. Harry J. Malony and Lee O. Wright, Ordnance Department; and Lieut. Col. Harold E. Hartney and Capts. Alfred D. Hobley, Harry A. Sutton and Burdette S. Wright, Air Service.

Harrison Declines Directorship.—C. L. Harrison, chief of the United States Ordnance Department in the Cincinnati district, was offered the post of director of public safety to succeed the late John R. Holmes, by Mayor Galvin. Mr Harrison declined the offer.

"I would not consider the public safety directorship, or any other position, until I have completed my present work," said Mr. Harrison. "I would not commit myself now as to whether I would even then accept the directorship if it were offered to me." he added.

Aero Motor Gun Invented.—The Wright Aeronautical Corporation has made public the invention of an airplane cannon motor which, while driving the plane in flight, automatically fires in rapid succession shells an inch and a half in diameter and weighing a pound each. According to the specifications, the engine is a modification of the 300-horsepower Hispano-Suiza. A 37-millimeter automatic cannon is arranged so as to lie along the inside of the propeller shaft, the muzzle projecting through the hub of the propeller. Two machine guns are attached to the same motor, all being operated by the engine.

This type of airplane ordnance is possible only because it is part of the engine, according to the makers. It is designed to pierce armored airplanes, tanks, submarines and dirigibles.

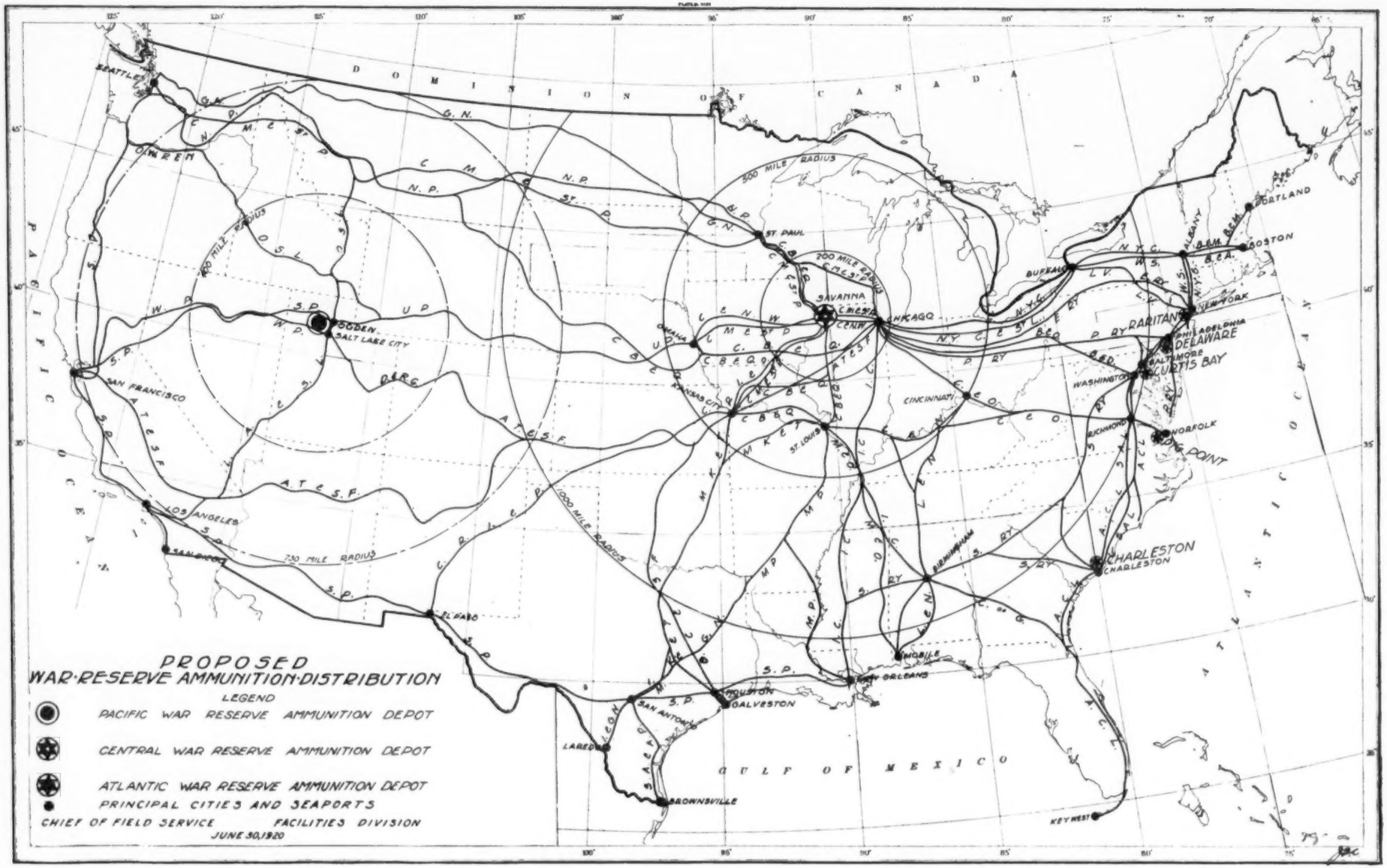
"The value of this motor in aerial combat is readily seen," said John R. Cautley, of the Wright Aeronautical Corporation. "It gives the pilot a greater fighting capacity, as heretofore with only a machine gun or two for offensive or defensive purposes, he had but a small chance of successfully attacking armored implements of war except with bombs. With his engine aiding in pumping bullets capable of piercing thick armor he can do effective work in combating the enemy. Using this kind of ammunition it would be almost impossible to miss an airplane within range of the cannon." —*Army and Navy Register.*

Proposed Ordnance Details.—About 25 applications have been received from permanent lieutenants of the army for detail to fill vacancies in the grade of first lieutenant in the Ordnance Department. About 16 vacancies now exist.

The service records and general suitability of the applicants will be considered, and it may be decided to conduct a written and oral examination of the applicants before those to be selected are determined. The details will be made for a period of four years.

Canadian Power Co. to Build Hydro-Electric Plant.—The Bridge River Power Co., Ltd., of Vancouver, B. C., is to develop hydro-electric power at the Bridge River power site. A total of 400,000 continuous hp. will be available when the site is fully developed and power in blocks of from 5,000 kw. up will be available within two years' time. Power will be sold as low as $16 per hp. year, depending on whether the plant consuming the power is located at the power house or at a distance, also on the power and load factors.

Germany's Potash Industry.—It is reported that the net profit of the German potash industry for the year 1919 was 7,661,511 marks, as compared to 2,317,667 marks for 1918.


PROPOSED
WAR·RESERVE AMMUNITION·DISTRIBUTION
LEGEND
PACIFIC WAR RESERVE AMMUNITION DEPOT
CENTRAL WAR RESERVE AMMUNITION DEPOT
ATLANTIC WAR RESERVE AMMUNITION DEPOT
PRINCIPAL CITIES AND SEAPORTS
CHIEF OF FIELD SERVICE FACILITIES DIVISION
JUNE 30,1920
DOMISION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
SEATTLE
TACOMA
PORTLAND
BOSTON
NEW YORK
ALBANY
BUFFALO
ST PAUL
CHICAGO
OMAHA
ODGEN
SALT LAKE CITY
SAN FRANCISCO
LOS ANGELES
SAN DIEGO
EL PASO
SAN ANTONIO
HOUSTON
GALVESTON
LAREDO
BROWNSVILLE
NEW ORLEANS
MOBILE
BIRMINGHAM
ATLANTA
CHARLESTON
NORFOLK
RICHMOND
WASHINGTON
BALTIMORE
PHILADELPHIA
DELAWARE
RARITAN
CURTIS BAY
CINCINNATI
ST LOUIS
KANSAS CITY
KEY WEST
500 MILE RADIUS
700 MILE RADIUS
750 MILE RADIUS
1000 MILE RADIUS

Ogden Arsenal

By

CHARLES R. BAXTER

Charter Member A. O. A.

ON November 11, 1918, with ammunition in all stages of completion in sufficient quantity to insure a steady flow of large volume in complete form to the troops in France, the Ordnance Department found itself for the first time in many decades in possession of ammunition far in excess of actual current needs. A few months after this date, when data had been collected as to the quantities and condition of all this ammunition, a board was appointed, known as the Munitions Board, to decide upon the amounts of this material to be held as a war reserve to furnish the initial quantities of ammunition in the event of a future war and to decide what of this material should be retained for training purposes, etc. The schedules of material to be retained were made up after giving consideration to the deterioration of ammunition in storage over a long period, the salvage value of this material at the present time, its cost to the Government, the estimated cost to replace, and the time required for the United States again to get on a production basis for this type of material in the event of another war.

Without going into any of the details as to how the Munition Board arrived at their figures as to what would constitute the War Reserve, in general it can be stated that it consisted of four distinct classes:

First. All loaded shell.

Second. Inert components of shell, primers, fuzes, etc., which had not yet been assembled and are non-inflammable and non-explosive.

Third. Bulk smokeless powder not yet made up into propelling charges, and the made-up propelling charges for separate loading ammunition, which are considered, as far as the storage problem is concerned, as bulk smokeless powder.

Fourth. Bulk high explosive, which had not been assembled into shell and which must be stored as bulk high explosive. This consists of TNT, Amatol, Picric Acid, Mercury Fulminate, Tetryl, etc.

The money value of the ammunition and components which will constitute the war reserve is $653,121,161.63. This is not the cost to the United States, but the estimated cost to replace with manufacturing facilities available. The actual cost to the United States was several times this figure, due to the fact that these manufacturing facilities had to be developed. The approximate standard storage space required to take care of this material is as follows:

Class 1. Loaded shell—140 magazines (approximately 11,000 square feet per magazine).

Class 2. Inert components and small arms ammunition—1,255,100 square feet.

Class 3. Smokeless powder—241 magazines (approximately 3,000 square feet per magazine).

Class 4. Bulk high explosive and loaded primers and fuzes—320 magazines (approximately 1,500 square feet per magazine).

In addition to the above, there were certain quantities of ammunition which would not constitute a part of the war reserve, but which were on hand in finished form for which there was available artillery and which would be very desirable for use in connection with the training of troops. This ammunition had a value of $117,477,786.41, and storage space must necessarily be provided for it. The space required to store this ammunition was in excess of twenty standard magazines and 107,000 square feet of general warehouse space.

Furthermore, there was an additional quantity of smokeless powder which was designated to be retained in addition to the actual amount required to complete the loading programme. This required considerably in excess of 100 magazines.

There were also to be retained 300,000 long tons of sodium nitrate which must be stored.

The total requirements of the Ordnance Department, therefore, for ammunition storage were as follows:

Class 1. Loaded shell—160 magazines (8,000 carloads).

Class 2. Inert components of small arms ammunition—1,375,000 square feet. Nitrate—300,000 long tons (12,500 carloads).

Class 3. Smokeless powder—340 magazines (3,400 carloads).

Class 4. Bulk high explosives, etc.—320 magazines (1,600 carloads).

Prior to the war, there had been on hand as compared to present figures practically no ammunition of any kind. Pre-war ammunition storage space available for this ammunition would take care of less than 1 per cent. The ammunition as it actually was stored

during the year 1919 was distributed among the following places:

First. Among the five big assembling and shipping depots along the Atlantic seaboard which were built during the war with good rail facilities and with dock facilities on deep water, so that shiploads of ammunition could be accumulated for movement to the other side.

Second. Ammunition still in the loading plants which had to be taken out by the Ordnance Department to release the plants for commercial work.

Third. Considerable amounts of ammunition which had been sent abroad and were being returned.

Fourth. Large amounts of ammunition which had been stored since the armistice in a number of Government-owned loading plants which were converted into temporary storage.

Fifth. In the case of high explosive, stored in isolated Government-owned areas in piles of a quarter of a million pounds each, covered with corrugated iron or temporary wooden sheds.

With the exception of the high explosive, practically the entire amount of ammunition was stored on the Atlantic seaboard. This ammunition was strategically misplaced and was also a menace to the neighboring large communities. The opportunity offered at this time by the material on hand, by the temporary nature of the greater part of the storage, etc., was an excellent one for embarking on a permanent ammunition storage programme consistent with economy and good military strategy. Based on the latter, a general policy was adopted as follows:

It was considered desirable to store 25 per cent of the finished ammunition, which was a part of the war reserve and available for immediate use, along the Atlantic seaboard, where it could be issued promptly in the event of hostilities; to store 15 per cent available for prompt shipment to the Pacific seaboard in the same way; in both these cases this ammunition to be in finished form available for immediate use; the remaining 60 per cent in its present state—that is, either finished or in the form of components, to be stored somewhere in the center of the United States where it would be safe from invasion and available for prompt shipment to loading plants, assembling plants, etc.

After having adopted this general policy, it was found that the existing permanent depots along the Atlantic seaboard built during the war, which extended from New York City to Charleston, S. C., were able to take care of the 25 per cent which would be made available for the Atlantic seaboard even when the unit quantities per building had been reduced so as to remove the menace that now exists toward the neighboring communities. There was no permanent ammunition storage of any kind west of the immediate Atlantic seaboard. Therefore, there existed no storage available to take care of the 15 per cent for the Pacific Coast or the 60 per cent for the central reserve. The first step was to attempt to find Government-owned reservations with proper requirements to take care of these two storage depots. In the case of the one for the Pacific Coast, the following features were essential:

(*a*) That it be accessible to the entire Pacific Coast from Seattle to San Diego by good rail facilities and with as many different lines as possible, so as to eliminate the danger of this depot being cut off from the supply of troops by the blowing up of tunnels, bridges, etc.

(*b*) It should be near enough to the entire Pacific Coast to enable ammunition to be moved from the depot in carload lots in a very short time, namely, two or three days.

(*c*) It must be far enough removed from the actual coast line to avoid the danger of its being taken by a sudden attack which would throw the immediate supply of the troops operating on the Pacific Coast on the next eastern depot, which would undoubtedly be 1,500 to 2,000 miles farther east.

(*d*) There must be sufficient land to contain the necessary number of magazines to store this 15 per cent, with at least the safety zones along the edge of the magazine area and between magazines, as prescribed by the American Table of Distances.

(*e*) It must be far enough from concentrated population to avoid the danger of an explosion being a menace to a large number of neighboring people.

(*f*) It must be so situated as to be as free as possible from the danger of population moving toward it.

(*g*) It must be near enough to a labor market to draw on the neighboring population for the current working force of 75 to 150 men and the working force, which must be picked up in the event of emergency, of several hundred men.

(*h*) The soil should be preferably sand, in order to avoid the ground shock, which is more violent when these magazines are built on more solid foundation.

(*i*) There should be sufficient water for fire protection and domestic purposes for the garrison and at the same time the lack of water is desirable in that it is an assistant in keeping down the vegetation around the magazines, which lowers the fire risk from grass or brush fires.

(*j*) A high, dry climate tends to increase the life of ammunition, particularly as regards smokeless powder, and is therefore desirable.

With these considerations in mind, investigation was started toward the location of the Western depot. Any location in California along the Southern Pacific or Western Pacific railroads leading into San Francisco had the disadvantage of low, moist climate, and of being not only a long haul from Seattle and San Diego, but one which parallels very closely the coast line and therefore is more readily cut. There was also the disadvantage of additional freight cost of shipping this ammunition from the east and then later shipping north to Seattle, as, on account of the nature of this material and the nature of the storage, a "storage in transit" rate could not be obtained.

Investigation was continued with the idea of lo-

cating to the east along the Union Pacific R. R. The only existing Government-owned reservations under the control of the military in this vicinity which were anywhere near sufficient size to take this storage project was the Sherman Reservation, otherwise known as the Pole Mountain Reservation, in Wyoming, a few miles west of Cheyenne and Fort Logan Target Range, Colorado, south of Denver.

The Pole Mountain Reservation was unsatisfactory, due to the very severe winters and the fact that for considerable lengths of time in winter rail transportation for moving this material in the event of emergency would be almost impossible. The operating cost during this weather would be very high. The cut-up nature of the ground would make the initial construction costs for railroad trackage, etc., very high and the labor market within a reasonable distance is almost zero. It is also much farther from the Pacific Coast than was desired.

The Fort Logan Target Range was not big enough to give the desired safety zone, was removed from labor market, was farther from the Pacific Coast than was desired and was on a very poor branch line of railroad.

The elimination of the existing military reservations available for this work then brought on the investigation of sites not already controlled by the War Department. Consideration, of course, was given Government-owned land, either forest reserve or desert land not yet taken up. In general, it can be stated that land not yet taken up under the homestead act is far removed from cities and consequently far removed from labor market; that forest reserve land is land which is not well adapted to storage purposes on account of several undesirable features.

From the strictly railroad standpoint, of course, the most desirable location would be in the vicinity of Ogden or Salt Lake City, at which points two railroads from the east converge, namely, the Union Pacific, which is double-tracked practically all of the way from Chicago, and the Denver & Rio Grande. Incidentally, there is now proposed a third line of railroad from Salt Lake City to Denver, which will probably become a fact within the next few years. From this point westward there are the following direct through lines:

The Los Angeles & Salt Lake R. R. directly to Los Angeles, with a mileage of about 900 miles.

The Southern Pacific and the Western Pacific, closely paralleling lines, directly to San Francisco, a distance of approximately 800 miles. Of these, the Southern Pacific is double-tracked for a large part of the way.

The Oregon Short Line directly to the Pacific northwest, approximately 900 miles.

In addition, it is possible to take the Oregon Short Line north and connect with the Milwaukee & St. Paul west or the Northern Pacific west to Puget Sound points, so that in general it can be stated that there are five radiating lines westward from this point to the Pacific Coast which would supply the southern Pacific and the northern Pacific Coast at about the same distance as would be the case were this depot located at San Francisco, while in the case of San Francisco itself the distance is not excessive.

Furthermore, the climatic conditions in this valley, with an elevation of nearly 5,000 feet, are very satisfactory for ammunition storage. The valley was first investigated with the idea of using the Government-owned target range which is some 20 miles south of Salt Lake City. Here, on account of the cut-up nature of the ground, the poor water supply, the distance from labor market, etc., the construction and operating costs would have been far too heavy to warrant the selection of this site.

Consideration was given the Government-owned land in the Salt Lake desert west of the Salt Lake and the Government-owned land in the mountains to the east of the Salt Lake. Here, again, the distance from labor market was not desirable and construction costs, due to local conditions in the way of lack of water, uneven ground, etc., were apt to be very high. It can be seen that an investigation of these sites led to a narrowing down of the possible field to the actual valley bottom which runs north and south from a point about 75 miles south of Salt Lake City into Idaho. This valley is traversed by several paralleling railroad lines, not only steam but electric, on the latter of which excellent passenger as well as freight service is maintained. It can be seen, therefore, that if land could be obtained and other requirements could be met along this electric line the labor problem would be largely solved in that passenger service was available at frequent intervals with a running time of less than an hour from the cities of either Salt Lake or Ogden, which are labor markets, as well as numerous small agricultural towns lying along this valley. The land on the floor of the valley is very high-priced and is heavily populated where water is available for irrigation. The land above the highest irrigation ditch is very low in price, being available for dry farming and grazing only, and is very sparsely populated. These considerations then led to the final selection of a piece of land 1 mile wide and 2 miles long, lying entirely above the highest irrigation ditch on a point of sand ridge which is practically level for 1 square mile, which adjoins the electric double-tracked railroad connecting Ogden and Salt Lake City and which maintains hourly passenger service. It is located 7 miles south of Ogden with a deep canyon intervening, which will practically eliminate the possibility of the city growing up to or around the site, and has no single existing building within a mile of

the ammunition storage area, with very little likelihood of water being brought in high enough to irrigate surrounding land. The land itself is largely loose sand with little vegetation, where a reasonable water supply can be obtained by drilling, and where within 7 miles is the transfer point of the electric railroad to the steam lines as follows:

The Union Pacific, the Oregon Short Line, the Southern Pacific, the Los Angeles & Salt Lake, the Denver & Rio Grande, the latter of which transfers at Salt Lake City, 37 miles south to the Western Pacific.

The electric railroad itself is a double-tracked line running from Ogden to Salt Lake City, a distance of 37 miles on which is maintained hourly passenger service and electrically operated freight service.

As has been previously stated, this valley, particularly between Ogden and Salt Lake, is well laced with railroad trackage and the possibility of this depot being cut off from having outlet in any direction is almost zero.

The accompanying map shows the strategic location of this depot with reference to the coast and the eastern supply points.

With these facts all assembled, the proposition was put before Congress and their authorization was obtained for the purchase of the necessary land and the erection of a storage depot at this point. The land is now nearly all purchased and actual construction will begin within the next few weeks.

News of the Districts

St. Louis District Canvass

Mr. M. E. Singleton, until recently Chief of the St. Louis Ordnance District, has just organized a Membership Committee for securing eligible members residing within the old St. Louis Ordnance District.

Assisting Mr. Singleton, who is President of the Missouri State Life Insurance Company, are Stewart McDonald, President, Moon Motor Car Co.; W. A. Layman, President, Wagner Electric Manufacturing Co.; A. J. Siegel, President, Huttig Sash & Door Co.; John Olin, Vice-President, Western Cartridge Co.; E. B. Meissner, Vice-President, St. Louis Car Co.; Charles W. Frees, Treasurer, Curtis & Co. Manufacturing Co.; W. H. Whitton, Vice-President, Laclede Gas Light Co.; C. P. Bascom, General Manager, Fayette R. Plumb, Inc.; Webster Colburn, Vice-President, Dorris Motor Car Co.; Harry Scullin, President, Scullin Steel Co., with Boyle O. Rodes, 1601 Railway Exchange Building, St. Louis, Mo., acting as Secretary.

New Members in the Philadelphia District

An efficiently organized canvass for additional members in the Philadelphia District was managed by Mr. John C. Jones, during the war, and now Chief of the Philadelphia Ordnance District.

Mr. Jones assembled and energized a very strong Membership Committee, consisting of William P. Barba, 3107 Coulter Street, Philadelphia, Pa.; E. M. Chance, Day & Zimmerman, Philadelphia, Pa.; William T. Dunning, Vice-President, Chester Steel Casting Co., Chester, Pa.; Irenee duPont, President, E. I. duPont de Nemours & Co., Wilmington, Del.; E. T. Kieffer, Superintendent, Victor Talking Machine Co., Camden, N. J.; George H. Markell, Treasurer, Hercules Powder Co., Wilmington, Del.; J. B. McCord, Stoneleigh Court, Washington, D. C.; Frank Overn, General Manager, Federal Steel Foundry Co., Chester, Pa.; C. W. Pike, 1109 Finance Building, Philadelphia, Pa.; F. W. Pirchett, Frazier & Co., Philadelphia, Pa.; J. W. Rawle, Second Vice-President, J. G. Brill & Co., Philadelphia, Pa.; Winthrop Sargent, Jr., Standard Supply & Equipment Co., Philadelphia, Pa.; George Satterthwaite, Vice-President, Tacony Ordnance Corporation, Tacony, Pa.; Charles M. Schwab, Bethlehem Steel Co., South Bethlehem, Pa.; J. T. Skelly, Vice-President, Hercules Powder Co., Wilmington, Del.; Joseph A. Steinmetz, Janney-Steinmetz & Co., Philadelphia, Pa.; Samuel M. Vauclain, Vice-President, Baldwin Locomotive Works, Philadelphia, Pa.; W. J. Webster, President, Atlas Powder Co., Philadelphia, Pa.; Charles B. D. Wood, President, The Pressed Steel Co., Wilkes-Barre, Pa., and Bernard R. Young, Superintendent, Aetna Explosives Co., Mount Union, Pa., with Lewis H. Van Dusen, 1012 Stephen Girard Building, Philadelphia, Pa., acting as Secretary and William B. Williams, 1317 Spruce Street, Philadelphia, as Assistant Secretary.

Detroit District Membership Committee

Mr. Carl E. Huyette, formerly Chief of the Detroit Ordnance District, is Chairman of the Detroit District Membership Committee, with offices at 2713 Hamilton Boulevard, Detroit, Mich.

The other members of the Committee are Harry T. Cole, United States Radiator Corporation; Sherman L. Depew, Paige Motor Car Co.; Emmett Dwyer, Michigan Stove Co.; Richard P. Joy, National Bank of Commerce; John R. Lee, Wills-Lee Co.; Gilbert L. Loomis, Hayes-Wheel Co.; W. Ledyard Mitchell, Maxwell Motor Car Co.; John R. Searles, Michigan Smelting & Refining Co.; Herbert B. Trix, American Injector Co., and Alfred H. White, University of Michigan. James L. Weir, of the Ordnance Salvage Board, is acting as Secretary.

Chicago District Canvass

An active canvass for eligible members residing within the territory comprising the war-time Chicago Ordnance District has been inaugurated.

Mr. E. A. Russell, formerly Ordnance District Chief for the Chicago District, now Secretary of the Otis Elevator Co., is Chairman of the Membership Committee, which has established headquarters at Room 1604 First National Bank Building, Chicago, Ill.

The other members of the Committee are W. W. Coleman, President, Bucyrus Co., South Milwaukee, Wis.; J. G. Cowling, Vice-President, Federal Pressed Steel Co., Milwaukee, Wis.; A. R. Erskine, President, Studebaker Co., South Bend, Ind.; H. S. Johnson, Gisholt Machine Co., Madison, Wis.; James W. Lyons, 1420 Carroll Avenue, Chicago, Ill.; W. H. Vandervoort, President, Root & Vandervoort Eng. Co., East Moline, Ill.; George E. Van Hagen, President, Standard Forgings Co., Chicago, Ill., with Henry

(Continued on page 33)

Manufacture of Mark VIII Tanks at Rock Island Arsenal

By

HARRY B. JORDAN
Charter Member A. O. A.

EARLY in the Spring of 1919 there was received at Rock Island Arsenal one of the largest orders in its history. This order covered the assembly of 100 Mark VIII Tanks.

The Mark VIII Tank is a fighting tank, weighing about 40 tons when fully equipped and manned. It carries a complement of 8 men, 1 in the engine room and 7 in the fighting compartment. The 7 men consist of the officer in command, the driver, and 5 gunners; 2 of the gunners manning the 6-pdr. Hotchkiss guns and 3 the Browning machine guns. The tank is equipped with 2 Hotchkiss 6-pdr. guns and 5 Browning machine guns and provides storage for 200 rounds of 6-pdr. ammunition and 20,000 rounds of 30 cal. ammunition. The platforms for the 6-pdr. gun mounts are in sponsons, one of which is located on each side of the tank, pivoting on a vertical hinge partially into the interior of the tank when required, to reduce the overall width.

The motive power is a 12-cylinder Liberty motor developing approximately 400 hp. at 1400 r. p. m. The epicyclic transmission provides for two speeds forward and one speed reverse. In low gear, with the engine at 1400 r. p. m., the forward speed is 1.4 miles per hour; in high gear, 5.2 miles per hour. The gasoline supply of 150 gallons allows for ample cruising range. The caterpillar feature in the tank is so designed that no part of the tank extends to the front or to the rear beyond the treads, making it almost nonstallable.

Col. Harry B. Jordan
Commanding Officer Rock Island Arsenal

June 14, 1920.

Colonel H. B. JORDAN,
Rock Island Arsenal,
Rock Island, Ill.

Dear Jordan:

I have just received your telegram concerning the completion of the assembly of one hundred Mark VIII tanks on the 10th inst. and I congratulate you on the successful termination of this order.

Sincerely yours,

[Signed] C. C. WILLIAMS,
Major General, Chief of Ordance, U. S. A.

The hull, which is constructed of armor plate, angle iron, steel channels, etc., provides the framework for carrying the engine, transmission, fighting equipment and accessories.

There were no buildings at Rock Island Arsenal specially adapted for the assembly of the Mark VIII tanks on a production basis. The craneway of Shop M (a clear assembly space approximately 60 by 500 feet) equipped with two 15-ton cranes, provided the best space for the hull assembly. In this space it was possible to work on approximately 30 tanks at one time. Each tank occupies a floor space of approximately 410 square feet; *i. e.*, length 34 ft., width 12 ft. While the assembly space in the craneway of Shop M was less than should

Train load of thirty-four cars carrying Mark VIII Tanks

have been available, still the building offered excellent facilities in other respects. It was the only building at the arsenal which had doors wide enough to permit tracks entering one end of the craneway and its cranes offered excellent facilities for moving material from the cars to the floor and for transferring material on the floor. Auto trucks could also unload inside the building.

In addition to handling component parts, the cranes were used for advancing the tanks along the floor during the various stages of assembly. The lack of space made it impossible to complete a tank in place; it necessarily had to be handled on a progressive assembly basis, very similar to that used at most automobile factories. Machine space adjoining the assembly floor was used for the storage of component parts and for a certain part of the sub-assembly work.

The road test followed the assembly, a suitable field located at the southwest corner of the island, approximately three-quarters of a mile from the shops, being utilized. Access to this ground was had by means of two roads, one paved, the other unpaved. An interesting fact developed was that to pay for the repair of the paved road, due to use by tanks, was more economical than to use the unpaved road and pay for the cleaning of the tanks.

Additional Facilities Needed

In order to be able to carry on this work in the craneway of Shop M, it was necessary to move all salvaged machinery and material stored there. The work of moving the machinery was delayed due to the fact that other machinery, declared obsolete, had to be moved before the salvaged machinery could be handled.

Prior to the moving of the salvaged machinery and material, there was only 6,500 square feet available floor space in which to carry on the assembly of the tanks. After all this had been cleared away, approximately 25,000 square feet of floor space was then available.

As the work proceeded it developed that additional floor space must be provided. This space was furnished by taking over parts of the first and second wing and a large portion of the bay of the first floor, adding approximately 15,000 square feet, and giving a total of 40,000 square feet.

The second wing of the first floor was used for the repair and modification of Liberty motors and transmissions, requiring the installation of overhead trolleys.

In addition to this a number of the sub-assemblies were made in different buildings, as there was no available space for these in the craneway or in the other parts of Shop M. The craneway not being designed for assembly work, it became necessary to install high pressure air lines for the air hammers and wiring for the electric rivet heaters. Then, the electric rivet heaters not furnishing rivets as fast as they were used by the various riveting gangs, it became necessary to install crude-oil furnaces with incidental low-pressure air piping.

Wood horses, trestles and benches were also needed in large quantities for the large force of men engaged in riveting.

Organization

A great deal of difficulty was encountered in building up an organization suitable for handling this class of work, this being the first time work of this nature had ever been attempted at this island.

During the assembly period; *i. e.*, from September 1, 1919, the time when the work really got under way, to June 10, 1920, the date the last tank was completed, the arsenal witnessed a very high percentage of labor turnover on this particular job. During this time there were approximately 3,000 employees engaged upon this assembly work, although at no time were there more than 819 employees actually on the floor; in other words, the labor turnover in a period of approximately nine and one-half months was virtually 400 per cent. It is to be noted that these figures pertain only to the assembly work and not to the personnel engaged upon the manufacture of component parts. The difficulty of making satisfactory progress under such adverse conditions can well be appreciated by anyone familiar with manufacturing work. This tremendous turnover was due to exceptionally high wages paid on the outside (Government adjustments of wages having to follow commercial firms and not precede), and to the fact that knowing that the work at the arsenal would practically cease on June 30, 1920, men were seeking permanent employment elsewhere.

Sub-Assemblies

In planning the work of assembling the Mark VIII tanks, it was advisable to divide the work into various

from Rock Island Arsenal, Ill., to Camp Meade, Md., May 21, 1920

sub-assemblies, allowing the work to be placed on as nearly a production basis as possible; *i. e.*, keeping a certain force of men on each separate, distinct operation.

In the assembly of each Mark VIII tank there are approximately 250 sub-assemblies; and, as previously stated, due to the limited amount of floor space, it was necessary to make some sub-assemblies in various departments throughout the entire Artillery Vehicle Section.

Among the most important of these sub-assemblies were:

Side doors for main hull,
Petrol cover doors,
Ammunition chests,
Outside tool boxes,
Peep-hole covers,
Engine-room doors,
Switchboards,
Officers' chests,
Ball mounts,
Tin-hat compartments,
Gauge boards,
Shell-stop bars,
Pressure-regulating tanks,
Combination tap bodies for petrol tanks.

The Liberty motor, when received at this arsenal, was supposed to be ready for installation into the tank, but it developed that, owing to this being an airplane type motor, some modifications would be necessary before the motor would be suitable for the heavy duty to which it was to be subjected in the tank. All were modified by changing from the Zenith to a Ball & Ball carburetor, and by installing in each governor a ball cup and retainer. It was also necessary to remove the distributor heads to synchronize them and to time the cylinders according to the breaker box.

The transmission was not suitable for the tank until some modifications had been made. The insertion of a reinforced internal gear was no short nor simple job.

Order of Assembly

The main hull was the largest assembly and required a force of thirty rivet drivers, thirty buckers and thirty heaters to keep this assembly moving fast enough for the men making the sub-assemblies into the main hull. This work consisted of the assembly of such parts as the girders, hull, side plates, mud chutes, roofs, floors, turrets and road track rollers. The majority of the material mentioned above is ½-inch armor plate and angle iron, secured together by approximately 8,000 11-16 inch rivets—a job of riveting requiring great care in many cases. The man and officer's turrets are the second largest sub-assemblies on the tank.

Engine Room Assembly

The placing of the transmission follows the hull assembly. The motor then follows, connecting to the transmission by means of compound clutch (epicyclic type).

The cooling system, consisting of radiator, water tank, sirocco fan and fan drive, is next installed.

The electrical equipment follows, consisting of:

One 12-volt generator, used for ignition,
Two 6-volt generators, used for lights, batteries and spark,
Two 12-volt storage batteries,
One 6-volt storage battery.

At this time all wiring necessary for the lighting, ignition and control is put in place. These wires are all run through flexible conduit for protection from fire and damage by walking on them or by coming in contact with metal parts about the motor and transmission.

The petrol and air pressure systems are then installed. The petrol system, consisting of three 50-gallon petrol tanks, is located in the rear of the tank, back of the engine room, and is protected from the sides of the tank by means of wood packing strips covered with felt. The flow of gasoline is regulated through a pressure-regulating tank located just over the motor. This practically completes the engine-room sub-assemblies.

Fighting-Compartment Assembly

The remaining sub-assemblies are then confined to the fighting compartment, which consists in the assembling of the gun-hanger bracket for Browning machine guns, ball mounts, periscope and spare barrel clips, peep-hole covers, head rests, periscope holders, semaphores, fire extinguishers, brackets, control units, driver's seat, engine-room doors, tin-hat compartments, officers' chest and various other miscellaneous assemblies.

While the assembly of the sponsons is one of the largest sub-assemblies and one of the first started, the sponsons are not assembled to the tanks until practically the very last. The sponson itself consists of armor plate, angle iron, ammunition storage chests,

Rock Island ruggedness of construction was strikingly demonstrated when this overturned tank, on being righted, started off under its own power

Hotchkiss 6-pounder guns, sponson track rollers and gunners' seat.

Caterpillar Assembly

The driving sprockets are placed on the tank, followed by the track shoes, consisting of two tracks of 78 shoes each. The tracks are assembled to the hull as follows: Four sections comprise the complete assembly; two sections are laid upon the floor, the proper length of the hull. The hull is then raised and set upon these sections. A crane cable is then hooked to one end of another section and raised high enough so that the link can be coupled to the section which is on the floor. It is then drawn along the top of the tank, at the same time lowering the track to the hull. The tracks having been adjusted to proper tension on the hull by the track-adjusting screws, the tank is ready for road test.

Product of Components

Most of the component parts that were to be used in the construction of the Mark VIII tank were purchased by this country from the British Government. These parts consisted of the heavy structural parts of the tank, *i. e.*, armor plate, angle iron, steel girders and channels, and a large quantity of the equipment carried, such as tools, Hotchkiss guns, camouflage nets, water cans, bird cages, food cans, telescopes, periscopes, festoon lamps, semaphores and various other sundries. All material shipped from England to this country was sent to Raritan Arsenal for temporary storage, for reshipment to Rock Island Arsenal. The balance of the material required in construction was manufactured by various outside contractors throughout the United States and was also shipped to Raritan Arsenal. These items were the Liberty motors, transmissions, compound clutches, petrol tanks, radiators, electrical equipment and front control units.

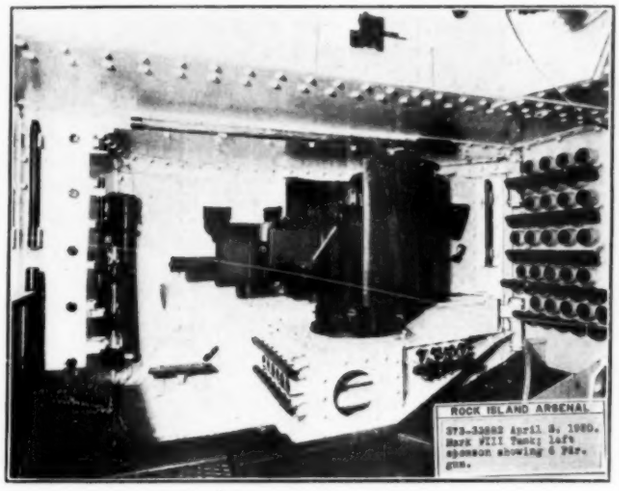
Upon the first inventory of material received it was found that only 65 per cent of the necessary material was on hand, and Raritan Arsenal reported that many of the essential parts needed had not been received at that arsenal from the contractors. It then became necessary to send men to a number of these contractors throughout this country to urge completion of the work, to trace and have the shipment of these parts expedited. Due to congested freight conditions, strikes and other causes it was impossible to

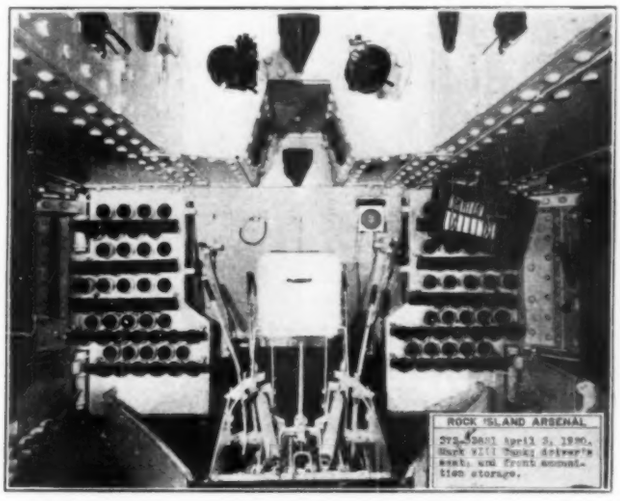
procure some of these parts in time to be of any assistance in the assembly and, therefore, a number of parts were manufactured here to prevent delay in production.

It was necessary to purchase bolts, rivets, lock washers, pipe fittings, angle iron, gauges, tubing, raw material and numerous other items in large quantities. The rivets used in most of the assemblies were an odd size, not in common use in this country, and it was a difficult matter to secure proper stock for manufacture.

Manufacture of Components

As stated above, approximately 35 per cent of the parts entering into the construction of the Mark VIII tanks had to be manufactured at this arsenal. These consisted of such parts as outside tool boxes, unditching angles, roller sprockets, roof, side, front and rear towing brackets; sponson hinges on hull, engine-control rods, battery shelf assembly, shell tubes, combination tap bodies, petrol-tank packing, track adjusting screws, bolts, nuts, cap screws and pins.





In the manufacture of these items it was necessary to make special tools, jigs and fixtures in order to get production. It might be well to state, however, that most of the parts which were manufactured at this arsenal for the first 25 tanks were made without the assistance of any special tools, jigs or fixtures of any kind, in order to avoid delay in production; and in this way it gave a better idea as to just what tool, jig, or fixture would be best adapted for the work. This also gave time to have these tools, jigs and fixtures manufactured so that they could be used in the balance of the material required.

The items of bolts, nuts, cap screws and pins, as listed above, was probably one of the largest items which had to be contended with, as this quantity ran into the hundreds of thousands. The manufacture of bolts for this job alone kept approximately 25 mechanics and 30 turret lathes and automatic screw machines busy for a period of about four months. To better explain the quantity required, there was one item of $\frac{5}{8}$-inch tap bolts, Whitworth thread, of which there were 20,000 required for the manufacture of these Mark VIII tanks.

A quantity of the armor plate was received without heat treatment, and it was necessary that this armor plate be heat-treated before it could be used in the assembly of tanks. As this was practically the first time any work of this nature had been attempted at this arsenal, it was necessary to do a certain amount of experimenting to produce satisfactory results.

Practically all of the armor plate, steel angle iron, steel girders, etc., received at this arsenal had to be straightened to conform to drawings. This required a force of approximately 50 sheet-metal straighteners and helpers. These men were employed continually on this work during the entire period of construction.

As much of this material was manufactured from castings, it was necessary to keep a force of pattern-makers and molders continuously on this work.

There was a large amount of wood work necessary for these tanks, such as packing for petrol tanks, switchboards, gauge boards, shell-tube boards, map boards, Browning machine-gun rest blocks and officers' chests.

Tests

On February 2, 1919, a sample Mark VIII tank was received at Rock Island Arsenal from Bridgeport, Conn. After remaining at this arsenal for a few days it was ordered out for exhibition purposes to Clinton, Iowa; Iowa City, Iowa; Ottawa Beach, Mich., and Denver, Colo. It was then returned and sent to Savanna Proving Ground, Ill., where it received a road test of 2,155 miles.

A force of men familiar with the handling and operating of the Mark VIII tank were transferred from the Rock Island Arsenal to Savanna Proving Ground to handle this road test, which was conducted to determine any defects in the design of the working parts

of this tank. The most serious trouble developed by this test was the stripping of the teeth in the sprocket roller pinions. It also developed that the exhaust system designed and in use on this tank was not suitable; that the Zenith carburetor originally designed for the 12-cylinder Liberty motor of the aeroplane design was not suitable for this class of work and would have to be replaced with a Ball & Ball carburetor; that the V-belt driving the sirocco was unsatisfactory, calling for a replacement with a 3-inch leather belt, necessitating the changing of the V-pulleys to cast-iron flanged pulleys.

The design and material used in the petrol tank caused considerable trouble due to rust and scale getting into the carburetor. This caused some back-firing through the carburetor; and in a number of instances fires occurred, damaging the electrical equipment.

This road test was given only to the original tank shipped from Bridgeport; but each tank was given a four-hours' shop test to determine the satisfactory operation of the motor and to make any necessary adjustments. Upon the completion of this shop test, the tank was then placed on a road test for ten hours; after the road test it was carefully gone over and inspected, cleaned, painted and prepared for shipment.

Difficulties Encountered

In addition to difficulties mentioned under the heading of tests, the following are a few of the more serious difficulties encountered:

(*a*) On practically all the material which had to be riveted together it was necessary to drift the holes, due to inaccurate drilling, or to the expansion or contraction of these plates during the process of heat-treating. It became necessary in many cases to weld these holes and to redrill.

(*b*) In many instances cracks appeared in the armor after the plates were riveted in place. It was then necessary to remove these plates, necessitating the cutting out of all rivets. These cracks were so slight that they could not be detected before assembly and only appeared due to impact of the riveting hammers.

(*c*) When attempt was made to assemble the Hotchkiss guns to the sponsons, the base was found to be out of true, and it was necessary to remove them from the mounts and straighten them in hydraulic presses.

(*d*) Due to faulty design and construction of the petrol tanks, leaks were often discovered after assembly, and much trouble and delay was encountered in attempting to keep up the necessary pressure required to send gasoline to the carburetor.

(*e*) The revolving peep-hole plates, made of armor plate and about 6 inches in diameter, when received were so warped that they had to be surface ground on both sides before they could be used. There were 22 of these required for each tank, making a total of 2,200.

Incidents of Construction

The construction of the first Mark VIII tank was started July 1, 1919, and the last tank was completed and ready for road test on June 5, 1920, making a total of 286 days to complete the 100 tanks. The first tank was completed on January 5, 1920, and the last just five months later, making a total of 150 days used in the assembly of the tanks after getting on a production basis, or on the average of one tank every 36 hours on the basis of working 24 hours per day. The general assembly on the tanks did not start until about September 1, 1919, due to the fact that a great deal of time was spent in checking in material and waiting for the receipt of the various component parts which were to be shipped to this arsenal by Raritan Arsenal.

The greatest number of tanks which were produced in one week of six days was seven. The greatest number of tanks under construction at any one time was twenty-eight.

On November 13, 1919, the Tank Section was divided into three 8-hour shifts; 50 per cent of the men being employed on day shift, 30 per cent on the first night shift and 20 per cent on the second night shift.

The only "near" serious accident during the construction of the tanks occurred on March 22, 1920, while loading one of the tanks for shipment. The sill of the flat car gave way, allowing the tank to turn turtle off the car. The only damage resulting from this accident was a slight dent in the roof of the main turret and the bending of the semaphone, which damages were very easily repaired without removing the parts from the tank. The driver and mechanic, who were in the tank at the time, were in no way injured other than being slightly shaken up. The tank was righted by coupling another tank to it with towing cables and rolling it completely back on its track, after which it proceeded to the shop on its own power for necessary repairs.

On March 29, 1920, during road test of a tank at the testing ground, near the west end of the island, one of the tanks was run too close to the water's edge and in some manner slipped off, burying itself in the mud and water. The river stage was unusually high at this time of the year, and water coming in contact with the ignition system made it impossible to get the tank out with its own power. It was towed from the river by coupling two Mark VIII tanks together.

While under road test a number of tanks caught fire, through back-firing through the carburetor. These fires caused very slight damages and were easily

extinguished by the use of fire extinguishers supplied to the tanks for any emergeney of this nature. There was no one at any time injured or seriously burned in any fires of this nature.

The greatest number of men employed at any one time in the Tank Section was 819. Of this number there was approximately 10 per cent absent each working day. Due to the large labor turnover of employees in this section, a great deal of time was expended in instructing these men in the various operations entering into the construction of the Mark VIII tanks.

The following are averages of the different classes of labor used in the construction:

15 foremen and assistant foremen,
25 sheet-metal straighteners,
45 machinists, 30 heaters,
65 specialists, 100 assemblers,
30 riveters, 300 skilled laborers,
30 buckers, 200 laborers,

8 clerks in the office personnel, which included stenographer, follow-up men and messengers.

The successful completion of the job on schedule time was due to the exceptional interest in the work and the loyalty and co-operation of the foremen and permanent workers on the job.

The completion of these tanks was promised the Chief of Ordnance by June 15, 1920. It gave the writer great pleasure to inform General Williams of the completion of the last tank on June 10, 1920.

News of the Districts

(Continued from page 26)

M. Huxley, of Wilkinson & Huxley, Chicago, Ill., acting as Secretary.

Springfield Armory District

The territory formerly comprising the Bridgeport Ordnance District now comprises the Springfield Armory District of the Association.

District Headquarters are at the Springfield Armory, and every effort is being made to keep the District Membership interested in Armory affairs.

A Membership Campaign under the leadership of Col. Charles H. Tenney, President of the Springfield Gas Co., has recently been inaugurated and is yielding a highly satisfactory increase in the District Membership.

The other members of the Committee are Henry Brewer, Vice-President, Winchester R. A. Co.; Clifford D. Cheney; W. H. Eaton, Treasurer, Eaton, Crane & Pike; John P. Elton, Treasurer, American Brass Co.; A. W. Erdman, Pratt & Whitney; B. A. Franklin, Director, Strathmore Paper Co.; E. O. Goss, General Manager, Scovill Manufacturing Co.; Charles R. Hare, Production Manager, New Britain Machine Co.; Elmer E. Neal, Works Manager, Marlin-Rockwell Co.; Andrew L. Riker, Vice-President, Locomobile Co., and Samuel M. Stone, Vice-President, Colts' Patent Fire Arms Manufacturing Co., with Col. Julian S. Hatcher acting as District Secretary.

Boston District Activities

The Boston District Membership Committee of the Association, headed by Levi H. Greenwood, of Heywood Brothers & Wakefield Co., as Chairman, have increased the District Membership over 200 per cent.

The other members of the Committee are John W. Higgins, Worcester Pressed Steel Co.; Thomas F. Brown, Industrial Engineering Corporation; Thomas B. Doe, U. S. Cartridge Co.; Stuart W. Webb, Bond & Goodwin; John S. Holbrook, Gorham Manufacturing Co.; Harry C. Dodge, Gray & Davis, Inc.; Alvan T. Simonds, Simonds Manufacturing Co.; James C. Heckman, United Drug Co., with Fred A. Rogers, formerly Major, Ordnance Department, as Secretary.

Notes

Railway Artillery.—The outstanding features in the development of railway artillery in the United States during the last two years lies in the construction and test of the 14-inch gun railway mount, model "E." This gun and mount were designed in the Ordnance Office; the gun was built at Watervliet Arsenal, N. Y., and the mount at Watertown Arsenal, Mass. Gun and carriage tests at the Army Proving Grounds, and service tests at one of the seacoast fortifications have proven this mount to be one of the most serviceable pieces of railway artillery that we have.

The mount may be fired as a sliding mount from any well-ballasted track, but without any specially prepared foundations; it is provided with several degrees of traverse, so that a curved track is not necessary, as in the case of the usual type of sliding mount where no traverse is provided. The carriage is equipped with a base plate suitable for setting on bare ground or on a concrete plug, from either of which the gun can be fired in any azimuth. In target practice, at both long and short ranges, where moving targets giving the extreme rate of change in direction were employed, the practical use of this mount was well established, the general operation, rate of fire and percentage of hits being most gratifying.

Infantry Howitzer.—The Infantry accompanying guns, which were tested at Aberdeen Proving Ground, were manufactured by the Ordnance Department, the two types being copies of Italian designs examined by the Caliber Board in Europe. The first design completed was a 70-millimeter gun, firing a 6-pound projectile; the second design was a 75-millimeter gun, firing an 8.5-pound projectile. The object of manufacturing these two types was to provide models at an early date, in order to crystallize ideas and opinions on what characteristics this type of weapon should embody. The tests have clearly shown that these two models are not satisfactory to fulfill the specifications which have been proposed; *i. e.*, that this weapon shall be suitable as a substitute for both the 37-millimeter gun and the 3-inch trench mortar.

The Ordnance Department is now preparing designs of a weapon that will fire a 6-pound shell for direct fire, and a 10-pound shell for indirect plunging fire. The tests of the two Italian types have been suspended pending a metallurgical investigation which was found necessary.

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

VOL. I. JULY-AUGUST, 1920. No. 1.

BUT two years ago, civilization was saved from the Hun at Chateau-Thierry. To-day the enlightened nations of the world are being rudely brought to a tardy realization of the rapidly increasing power and extent of the Bolshevist menace.

War-weary as they are, necessity may yet drive them to resort to force of arms to insure that civilization shall not be deprived of the fruits of the World War. At any rate, the situation is not sensibly improved by ignoring its possibilities.

As a nation we seek not war, yet have undeniably advanced the cause of world civilization by repeated resorts to force when appeals for judicial determination of the issue would have resulted adversely. The Revolutionary War established the principle of no taxation without representation; the War of 1812 successfully contested the right of search; the Civil War abolished human slavery; the War of 1898 put an end to the Cuban atrocities, and the World War arrested the attempted world domination of Prussian militarism.

To-day no man can say whether or not our country is to be called upon to add the stamping out of blood-crazed Bolshevism to its past contributions to world welfare. Thoughtful men will, however, seek to determine from the lessons of the past our most intelligent course of present action in anticipation of any future eventuality.

In his recently published book "Ordnance and the World War," General Crozier enunciates a principle well-nigh axiomatic in its force—

. . . All other preparations, both in organization, personnel and materiel can take place faster than *the manufacture of arms and ammunition,* which therefore *sets the pace* at which the country can make ready to wage war.

Continuing, he points out that all activities incident to the production of Ordnance are in turn dependent upon the quickness with which executive personnel can be recruited, trained and assimilated into the great industrial organization for manufacturing the tools of war.

And yet to-day the Reorganized Regular Army, out of a total of 17,717 commissioned officers, allots but 350 to the Ordnance Department. Ninety-eight per cent of the brain power of the permanent forces is adverted either toward the solution of problems of every-day existence—feeding, clothing, paying, transporting, housing or healing men, or toward perfecting methods for training men in the use of arms, and a scant 2 per cent is available for solving the problem of producing these arms which must be ready before training in their use can even be begun.

As for auxiliary personnel, conditions are little better. In the Officers' Reserve Corps, but 3 per cent of the present total strength of 68,000 Reserve Officers is enrolled in the Ordnance Section.

Munition power—not man power—determines the military effectiveness of a nation. This was the outstanding lesson of the World War. The old pre-war ratio of "officially directed" attention to these two subjects was proved to be dangerously disproportionate by our own experience, yet it is maintained practically unchanged.

The logical remedy for this situation is obviously

NEW WORLD WAR FEARED BY BRITISH

Grave Misgivings Caused by Premier's Speech on the Polish Situation.

CIVILIZATION SEEN IN PERIL

Labor and Other Sections of Public Oppose Military Campaign. King Sees Lloyd George.

(Special Cable to The Washington Post and New York Sun-Herald.)

London, July 22.—"Is it a new world war?" That question was heard all over London today following the grave tenor of Premier Lloyd George's speech in the house of commons on the Russo-Polish situation.

Anxiety regarding this situation was reflected in the stock market to-[illegible] and co[illegible]ental ar[illegible]rit

to supplement the present inadequate permanent and reserve personnel by locating and organizing for effective co-operation all persons whose war work yielded them knowledge of Ordnance design or manufacture, which have, unfortunately, no parallel peacetime activity to stimulate their development and automatically furnish a readily available auxiliary personnel for the expansion of the permanent personnel in emergency.

In providing thus a larger field of personnel trained in the technique of Ordnance, and hastening the rate at which the Department can be expanded to execute the task upon which all other war activities must wait, a practical and constructive step is taken toward the Solution of the Ordnance Problem—The Crux of Preparedness.

In the final analysis, the Germans were not altogether foolish in deliberately determining upon unrestricted submarine warfare in spite of the positive assurance that it would bring the United States of America into the war against them. They figured that they could force a decision favorable to themselves before the military power of the United States could be brought into effect.

The Germans certainly knew of our almost inexhaustible man power, and of our tremendous educational plant for training this raw personnel in the use of arms. They knew, too, that paymasters could be improvised from bank tellers; commissaries from the great grocery and provision trades; transportation officers and engineers from our extensive railway systems and construction firms; signal officers from our highly developed telephone and telegraph companies; medical officers and dental surgeons from corresponding civilian professions, and motor transport officers from the greatest automobile industry in the world.

Discounting all these factors, they shrewdly calculated that there was in America no field of readily available personnel from which Ordnance officers could be improvised, certainly not to anything like the degree which obtained for all other technical and staff corps requiring tremendous expansion in the event of war. They realized that the production executives and plants of private corporations manufacturing munitions for the Allies prior to our entrance into the war, would be kept fully occupied in maintaining output on orders already placed, so that, in effect, the 97 officers of the Ordnance Department of the Regular Army would among themselves possess the sum total of knowledge of the design and manufacture of munitions immediately available to our War Department.

Eleven thousand officers were needed for the design, production and handling of Ordnance for our first 5,000,000 men. Practically it was this deficiency between what we had, 97, and what we needed, 11,000, that Germany counted upon to delay our effective participation until she had defeated our Allies.

In performing those industrial miracles which in the fall of 1918 made Germany realize that her calculations were wrong, that the *American Ordnance program was going through*, representatives of American science, engineering and industry, whether in uniform or in civilian clothes, supplied the unexpected increment of power which tipped the scales and decided the issue in favor of civilization instead of against it.

The signing of the armistice ended the necessity for the tremendous industrial machine into which American industry had resolved itself for manufacturing war material. It became necessary to slow down, and later to stop almost completely, the activities of thousands of plants and millions of workmen without so dislocating the industrial life of the nation as to lose in victory those attributes for which the country had struggled during the war.

Within a year and a half American industry has been almost completely diverted to the production of materials of peace. Manufacturers who had turned over their plants for war purposes have co-operated with the Government in a spirit of fairness and patriotism to effect the adjustments incident to the cessation of munitions production. With those representatives of industry who remained in service to handle the Government's side of these adjustments, they have performed a task no less valuable to the nation, no less wonderful in its way than the manner in which they built up the great industrial war machine that made Germany quit.

But, a third patriotic duty remains to be accomplished, one in which the Army Ordnance Association can take an active part. Past performance must be analyzed, mistakes recognized, constructive remedies determined upon and applied. Above all, effective measures must be taken to preserve, extend and disseminate the knowledge of the design and manufacture of arms accumulated at such great cost during the World War, to the end that our munition power may be forever ample to permit the full utilization of our man power and thereby render our country an effective factor in keeping the peace of the world.

The need is great—and may be immediate. The course is clear, our duty plain.

Let's finish the job.

Official Insignia

The Executive Council has decided that official insignia shall be issued gratis to all members. An order has been placed with the Bailey, Banks & Biddle

Co., of Philadelphia, Pa., for the manufacture of a number sufficient to take care of the present membership. Any member who joined the Association prior to August 1st, and who has not received his insignia by August 20th, is requested to notify the Secretary of the Association at Room 410, Munsey Building, Washington, D. C., giving address to which a duplicate should be sent.

To a large proportion of the Association membership, ARMY ORDNANCE comes unheralded. We trust it proves a pleasant surprise.

Furnishing the magazine to each member at no additional cost over the regular membership dues has been made possible through the generous assistance of a relatively few members. In embarking on this enterprise, it was manifestly impossible to utilize effectively the interest of all members. All could not write for the first number, nor were all in a position to support the magazine in the very practical manner of advertising.

There is, however, one outlet for the peace-patriotism of every individual member—securing desirable new members for the Association. Increasing the membership reduces the overhead expense of conducting Association business, as well as the cost of the magazine itself.

ARMY ORDNANCE wishes to be the *active* journal of an *active* association. Every *active* member will, we hope, help his copy to work for his association by loaning it to the most desirable eligible of his acquaintance.

A clip-coupon application card for use of prospective members is printed on another page.

A. O. A. Nominations

The Nominating Committee of the Army Ordnance Association has submitted the following report:

To the Secretary of the Army Ordnance Association:

The Nominating Committee of the Army Ordnance Association, appointed pursuant to resolution of the Executive Council of June 9, 1920, submits the following nominations for officers of the Association for the year beginning October 1, 1920:

For President: BENEDICT CROWELL.

For Vice-President: W. W. COLEMAN.

For Directors:

To Serve One Year—

SAMUEL MCROBERTS, GUY E. TRIPP, WALDO C. BRYANT.

To Serve Two Years—

ROBERT P. LAMONT, C. L. HARRISON, FRANK A. SCOTT.

Respectfully submitted:

RALPH CREWS, *Chairman,*
JOHN C. JONES,
LESTER W. BLYTH,
CHARLES H. TENNEY,
Committee.

The ballot for the election of the officers of the Association for the ensuing year, which is to be marked by the members of the Association and mailed to the Secretary, is printed on another page of this issue. It is supplied with blank spaces for the addition of other nominations which any of the members may choose to make.

Personnel

THE HON. BENEDICT CROWELL, a charter member of the Association, has resigned his office as Assistant Secretary of War. Upon accepting Mr. Crowell's resignation, President Wilson said: "It is most gratifying to know that the great business of the War Department in the procurement of munitions and supplies has been so satisfactorily handled and closed up. . . . It has been a pleasure to have your active and zealous work in the War Department, and in congratulating you upon your success I beg leave to express my appreciation and best wishes for your welfare."

Mr. Crowell has been nominated for President of the Army Ordnance Association by the Nominating Committee. Prior to the war he was a member of the firm of the Crowell-Lundoff-Little Co. Mr. Crowell entered the army as a Major of Ordnance and served in the Gun Division of the Ordnance Office. Later he was appointed Assistant Secretary of War and as Director of Munitions had entire charge of their production.

After the armistice he had charge of the demobilization of industries engaged in the manufacture of munitions and of the settlement of War Department contracts and claims arising thereunder.

In his announcement of Mr. Crowell's resignation Secretary Baker said: "His work has been of the highest value to the Government, and he generously resisted the pressure of his private affairs until his war work, with its consequences of intricate and varied contracts and claims, was practically cleaned up."

Since Mr. Crowell's resignation from the War Department he has returned to business as chairman, Crowell & Little Construction Co., of Cleveland, Ohio; member of the firm of Crowell & Murray, Mining Engineers, and President of Rosiclare Lead & Fluor-Spar Mining Co., with offices in Washington, D. C., where he is at present located.

MR. W. W. COLEMAN is President of the Bucyrus Co., of South Milwaukee, Wis. During the war he served as Special Assistant to the Chief of Ordnance in entire charge of the design, manufacture, inspection and test of all Artillery material, an experience which renders his counsel and assistance of great value to the Ordnance Association.

BRIG.-GEN. SAMUEL MCROBERTS, then Vice-President and Executive Manager of the National City Bank of New York City, entered the Ordnance Department in the fall of 1918. He was appointed Colonel and assigned to duty as Chief of the newly organized Production Division of the Ordnance Office. In this capacity he was responsible for negotiating and placing contracts for more than $5,000,000,000 worth of Ordnance. He was promoted to Brigadier-General in the fall of 1918, and was assistant to the Chief Ordnance Officer, A. E. F., when the armistice was signed. He resigned from the management of the National City Bank at the end of 1919 to enter business on his own account with offices at 14 Wall Street.

BRIG. GEN. GUY E. TRIPP, Chairman of the Board of Directors, Westinghouse Electric & Manufacturing Co., accepted an appointment as Colonel, Ordnance Department, in December, 1918. A full account of his war service appears on page 4 of this issue.

MR. WALDO C. BRYANT, President of the Bryant Electric Co., served during the war as Chief of the Bridgeport Ordnance District, in which was concentrated the major portion of small-arms and machine-gun manufacture.

COL. ROBERT P. LAMONT, President of the American Steel Foundries, Chicago, Ill., served during the war as Assistant

Chief of the Procurement Division, and after the armistice as a member of the Ordnance Claims Board.

MR. C. L. HARRISON, a manufacturer and banker, of Cincinnati, Ohio, served throughout the war as Chief of the Cincinnati Ordnance District, and is now finishing up Government business as Chairman of the District Claims Board.

MR. FRANK A. SCOTT, Vice-President of the Warner & Swasey Co., of Cleveland, Ohio, was appointed by the President of the United States to the highly important position of Chairman of the General Munitions Board, which later became the War Industries Board. Under Mr. Scott's guidance the productive capacity of the country was allocated to meet the demands of our Allies, the Shipping Board, the Navy and the Army—each in its proper order of priority. This tremendous task temporarily impaired his health to a degree necessitating his resignation in the fall of 1917, but the soundness of his judgment, and the force of his executive ability during the formative stages of the Board's development exercised a continuing beneficial influence throughout the war.

Assistants to the Chief of Ordnance

The appointment has been announced of two new assistants—Brig.-Gen. William S. Peirce and Brig.-Gen. George W. Burr—to the Chief of Ordnance, Maj.-Gen. C. C. Williams. Both officers are charter members of the Association.

BRIG.-GEN. WILLIAM S. PEIRCE graduated from West Point in 1888 and has served in the Ordnance Department for 28 years under three administrations. While he was stationed at Sandy Hook he designed a delay action fuse for heavy artillery projectiles which was adopted by the Department for use during the Spanish-American War. He was in command of the Springfield Armory from 1912 to the winter of 1918. At the beginning of the war it was necessary to increase the personnel of the armory from about 500 to approximately 4,500. The production of rifles had reached, prior to his release from the station, an average of 1,050 per day, and preparations were then in hand for an increase to 1,500 per day which was subsequently reached. In the winter of 1918 he was appointed Brigadier-General in the National Army and placed in charge of an important division of the Ordnance Office, and later served as Assistant Chief of Ordnance. Since the armistice he has served as Chairman of the Ordnance Claims Board which suspended all unfinished contracts and settled them. He remained on the Board while the organization for procedure of settling the contracts was determined.

General Peirce received a Distinguished Service Medal for services in connection with these duties and for service in greatly augmenting the supply of rifles while at the Springfield Armory. He was given the degree of Officer of the Legion of Honor by the French Government.

BRIG.-GEN. GEORGE W. BURR graduated from West Point in 1888 and has served in the Ordnance Department during the greater part of his Army career. His chief interests have been connected with the design, manufacture and issue of all types of heavy and light Ordnance equipment. During the war he was representative of the Ordnance Department in purchasing heavy artillery and munitions from the British Government and was assigned as Chief Ordnance Officer on the staff of Major-General Biddle in England. On August 8, 1918, he was appointed Brigadier-General in the National Army and assigned as Chief of the Engineering Division of the Ordnance Department. In December, 1918, he was appointed Assistant Director of Purchase, Storage and Traffic, and on March 5, 1919, was promoted temporarily to the grade of Major-General. He has received a Distinguished Service Medal for services during the World War.

Ordnance Reserve Corps

Letter from the Adjutant General

The following extracts from a letter addressed to the Secretary, Army Ordnance Association by The Adjutant General of the Army are of interest to every member of the Association:

"1. . . . The War Department greatly desires the cooperation of the Army Ordnance Association in maintaining the interest of Reserve Officers in the Army.

"2. . . . A careful review of your constitution and by-laws makes immediately apparent the desirability of your cooperation, and in carrying out the purposes of your Association through the medium of your magazine you can render much assistance to the War Department that will be highly appreciated.

"3. We now have a Reserve Corps of over 70,000 officers. Of these 2,600 are in the Ordnance Section of the Reserve Corps. Until the provisions of the recent Army Reorganization Act can be fully put into effect it will be impracticable to do much in the training and instruction of Reserve Officers. *In the meantime it is suggested that Reserve Officers be given what information and instruction is possible through the various associations and their publications.*

"4. It is understood that Reserve Officers are eligible and welcome in your association, which offers an existing and effective means of furthering affiliation and instruction. It is hoped that they will take advantage of the same and the Department feels confident your organization will be of service both to the officers and the War Department by the dissemination of matters of interest to the Ordnance Officers' Reserve Corps."

The Secretary of the Association has informed the Chief of Ordnance that all duly commissioned officers of the Ordnance Reserve Corps are both eligible and welcome to membership in the Army Ordnance Association; and also that, conformably to the suggestion of the Adjutant General "that Reserve Officers be given what information and instruction is possible through the various Service Associations and their publications," the Association will be glad to publish in its bi-monthly magazine any and all informative or instructive matter furnished by the Ordnance Dept.

General Williams has informed the Secretary of the Association that the Ordnance Department will gladly avail itself of the facilities of the magazine, not only for the instruction of Reserve Ordnance Officers, but for keeping in touch with American Industry in general, with a view to stating the fundamental conditions of the Ordnance Problem and securing the utmost of intelligent counsel and coordinated cooperation in our efforts toward its solution.

Training of Reserve Officers

The subject of training Ordnance Reserve Officers is being studied by the Ordnance Department and several different methods of training are now under consideration. One method that has been outlined is as follows:

(*a*) Publication of bulletins of information from time to time.

(*b*) Assignment of Reserve Officers for duty at Camps, Stations, etc.

(*c*) Organization within departments of skeleton organizations under supervision of a regular officer.

(*d*) Utilization of National Guard organizations.

(*e*) Utilization of R. O. T. C. courses, and of Special Service Schools.

(*f*) Arrangements for inviting Reserve Officers to visit Government plants and posts for observation of the routine duties, etc.

It is apparent from a study of the suggestions above that the question has been studied from the point of view of training line officers. The training of officers of a staff corps involves a consideration of the above outline but presents an entirely different and an added problem.

In considering this subject, it must be remembered that from now on there will be two classes of Ordnance Reserve Officers—those officers commissioned in the Reserve Corps before the War or during the War and who are now recommissioned in various grades from second lieutenant to colonel, and those new officers who are commissioned at the end of their R. O. T. C. course in the grade of second lieutenant.

Of the first class, the officers have had experience during the War and must be presumed to have been finally placed on the duty best suited to their qualifications. These officers are now being cataloged in accordance with the duties or functions with which they were most closely connected during the War. Their future training is then definitely limited to the class of work on which they were engaged. These officers are being invited to correspond with the Department on the ordnance subjects in which they are most interested.

The Ordnance Office will make every possible effort to send prompt and complete replies to these letters giving such information on the subjects discussed as is proper and furnishing the applicant with literature, pamphlets or other matter of interest. It has not been decided, as yet, just how these requests for information are to be handled, but it is evident that they will cover a wide variety of subjects. However the letters will be referred to the officers most competent by knowledge and experience to give the information desired. It is planned to make note of the fact that officers have corresponded and to use this information in judging the suitability of reserve officers for active duty.

There is a provision in the Act of June 4, 1920, authorizing the Secretary of War to assign reserve officers to active duty in times of peace not to exceed fifteen days in any calendar year unless with the consent of the officer. Under this provision it is possible to order reserve officers for duty at arsenals and establishments engaged in work pertaining to the activity with which the officer is identified as determined from the records in the personnel office of the Administration Division. During this brief period, it is believed much can be accomplished in the way of preparing reserve officers for active duty. This training would be arranged for in advance and schedules prepared covering the entire time in order that no time be wasted. The following establishments are suggested as places where this training may be carried on:

Small Arms	Springfield Armory
Explosives	Picatinny Arsenal
Ammunition	Frankford Arsenal
Tanks, Tractors and Trailers	Rock Island Arsenal
Artillery Division, Cannon	Watervliet Arsenal
Artillery Division, Carriages	Rock Island Arsenal
Projectiles, and Shop Practice	Watertown Arsenal

In addition to these places, officers identified with the more theoretical elements of design, might be ordered to Washington for service with the Technical Staff or the proper manufacturing division.

A further suggestion, which is limited, is to assign these officers who so desire to the School of Application at Aberdeen or to the School of Technology at Watertown. This scheme, is, of course limited to those officers who can spare the time from their civil pursuits. It may be the desire of some newly graduated R. O. T. C. students to pursue these courses with the idea that the work will be in the nature of a post graduate course.

Regarding the officers who will come into the Reserve Corps from the R. O. T. C. units, these officers come in as second lieutenants and when commissioned have attended at least one Ordnance Camp. They are subject to a fifteen day call the same as any other Reserve Officer and in the ordinary course of events would attend a Training Camp during that period. It is suggested that these officers be required to attend such a Camp, to be held at Aberdeen, and also be invited to correspond as in the cases of the officers of war time experience. After a time, these younger officers will have evidenced their interest or attainmnts along certain lines which, when discovered, will provide for sending them as suggested above, to some establishment for the fifteen day period rather than to a Training Camp. This plan appears to be flexible enough to permit the sending of officers either to an establishment or to a Camp as the Department may see fit.

In the course of time the Reserve Corps will be composed almost entirely of R. O. T. C. graduates, the older war time officers being passed out of the Corps by reason of death or failure to requalify at the conclusion of their five-year period of commission. These younger officers must, therefore, be promoted to higher grades in order to maintain the proper proportion of grades. Only by careful consideration of their work at the Camps during their fifteen-day period or their interest through correspondence, will it be possible to judge the merits of the officers and make recommendation for promotion. This problem of promotion has not been decided as yet, but will be the subject of policy to be outlined by the General Staff.

The present problem and the one in which the Ordnance Department is most interested is the problem of training the officers in the Reserve Corps and keeping them up-to-date on matters which will affect their value if called into service. The officer himself is in a position to aid or hinder any plans for training and much depends upon his attitude and desire for information. The fact that he is thirsty for knowledge and interested in the work and eager to obtain information and to keep up-to-date should weigh heavily in considering him for promotion. It is intended that the correspondence conducted with these officers will pass through the agency which will handle matters such as promotions and assignments so that the officers' own records will serve as to the best indication of their qualifications and adaptabilities for assignment and promotion.

Addresses of A. O. A. Members Wanted

Letters on Association business sent to the following members at the addresses given herewith were returned by the Postal Authorities for better address:

Capt. Robert W. Blair, 155 E. Superior St., Ordnance Dept., Chicago, Ill.

Mr. Frank W. Brown, 1746 S. St., N. W., Washington, D. C.

Lt. Val Allen Browning, 505 27th St., Ogden, Utah.

Lt. William K. Fitch, Dravo Doyle Co., Diamond Bank Bldg., Pittsburgh, Pa.

Mr. John S. Paul, Dale-Brewster Co, 54-60 Lafayette St., New York City.

Capt. Henry Lewis Slade, Jr., 50 Vanderbilt Ave., New York City.

If any one knowing the correct address of any of the above will communicate with the Secretary at 410 Munsey Building, Washington, D. C., it will be appreciated.

The Machine Gun of the Future

By

JULIAN S. HATCHER

Charter Member A. O. A.

THE history of the machine gun is remarkable for several things. One of these is the fact that it has been a very long time since any really revolutionary improvement has been made. The enormous use of the machine gun in the recent war gave it such a sudden prominence that there is a general impression that it is a recent invention. However, this is far from true, for the Maxim was produced in 1884 in very nearly the same form in which it was used by the British, the Russians, the Americans and the Germans in the World War. The only real changes made in the Maxim gun in the last 36 years have been those necessary to adapt it to the later types of ammunition. And, as a matter of fact, the latest guns of the Maxim type that we got out during the war did not even have this change, for they were made for the old 11 millimeter, or .44 caliber, French cartridge of 1874. Strange as this may seem, the reason for it was simple. Our air service needed a long-range incendiary bullet for burning balloons. The service .30 caliber bullet could not carry enough incendiary material. The idea had occurred to the French to use some of their old obsolete large-caliber ammunition for this purpose, as the bullet was big enough to carry a lot of incendiary material. This scheme proved so successful that our air service called for the same thing, and some of our Vickers guns were chambered for this same 11-millimeter cartridge.

Our ammunition factories also started making this old French cartridge with the new incendiary bullet. This cartridge and the converted gun made an excellent combination for attacking observation balloons. The bullet not only served as an incendiary to set the balloons on fire when they were hit, but also served as an excellent tracer to tell where they were going, as the flame from the burning incendiary mixture could be seen on the base of the bullet during its flight through the air.

The fact that we unexpectedly had to go back to a bullet which was years ago considered obsolete, shows that we can not prognosticate with extreme accuracy the future of the machine gun; but we can at least inquire what the trend of development has been in the past, and apply the lessons of the recent war to deduce what it is likely to be in the future.

By a review of the past trend of machine-gun development, we find that some of the most notable tendencies have been toward the following results:

The adoption of a relatively small caliber;
The reduction of weight;
The production of a simpler mechanism;
Better cooling.

In considering the question of calibers, we find that almost immediately after the machine gun was perfected, its construction in the larger sizes was begun. The early Maxims were built when the standard military size for small arms was .45 caliber, and the machine guns were accordingly made in this size first. The designers were very ambitious, however, and they aimed at a star by immediately trying to build their new gun to take cannon-sized ammunition. They made 1-pounder and 2-pounder automatic guns. The 1-pounder Maxim was quite widely used at one time, and became known to the public during the Boer War as the pom-pom. About this period all nations had a few guns of this general character. However, they were so heavy and unwieldy to handle that their popularity did not last. We used a few in our Navy during our war with Spain. Finally, all that we had found their way into museums or storehouses, and none have been used for a long time. It is interesting to note that the Germans brought out some of these old guns and used them during the war, probably for anti-aircraft work. Side by side in the Springfield Armory Museum are an American pom-pom of the Spanish-American War and a German pom-pom captured by our Infantry in the Argonne. The mechanism of the two guns appears to be identical.

After the pom-pom was eliminated from the race for popularity, the question of calibers for machine guns simmered down until it became standard practice to make the machine gun in only one caliber, which was that of the service rifle ammunition of the nation concerned. This status persisted until the

needs of the war caused a move toward larger calibers in the shape of a reversion to the 11-millimeter.

The effort to simplify the mechanism of the machine gun did not meet with rapid success. The Vickers of to-day is identical in principle with the Maxim of 1884, and is very little simpler, either to use or to manufacture. The Colt machine gun, invented by Browning in 1889, was almost as complicated as the Maxim. The first revolutionary advance in the direction of simplicity was the Browning machine gun of 1917. The reliability of its mechanism and its freedom from adjustments enable the soldier to obtain a large volume of fire without much mechanical training, and its simplicity from a manufacturing viewpoint enabled the American manufacturers who were building these guns for Army Ordnance to reach a production of 575 heavy Brownings per day. What this means can be better realized when it is understood that the maximum production of Vickers guns never reached more than 50 per day, in spite of the fact that they were in production when the war began, before the first model of the Browning had ever been tested.

The effort to reduce the weight of the machine gun has always been bound up with the cooling problem. The heating of machine guns is a serious disadvantage, for the heat of the explosion is so intense that a few hundred shots will make an ordinary rifle barrel red hot. In an effort to overcome this defect, Maxim placed the barrel of his first machine gun in a jacket of water which was intended to keep down the heat of the barrel. While this expedient allowed the firing of many thousand shots without cooling, it had several disadvantages. The weight and bulk of the gun were much increased. The supply of water became a serious problem, for it boiled away rapidly as the gun was fired. The boiling of the water produced a cloud of steam which threatened to disclose the gun position to the enemy observers. Moreover, the mechanical complications were serious, for the barrel had to recoil to operate the gun, and the application of a water jacket to a movable machine-gun barrel necessitated the use of stuffing boxes for the barrel to slide in at each end of the water jacket. In spite of these disadvantages, the water jacket has been retained for want of an effective substitute, and the most efficient guns of to-day, the Vickers and the Browning, both have the old water jacket in almost its original form. One of the needs of the future is a gun in which this cumbersome appliance is eliminated. In the effort to overcome the effect of heat, several other expedients besides the water jacket have been tried. The French in the Hotchkiss and the United States in the Colt and the Benet-Mercié, attempted to get away from cooling by building the barrel of the gun heavy enough to stand from 300 to 1,000 shots. In the Hotchkiss and Benet-Mercié the barrels were also make quick-detachable, on the theory that after several hundred rounds the hot barrel could be removed and a cool one substituted. Col. I. N. Lewis attacked the problem by the use of a draft of air as a cooling agent. The barrel of his gun was encased in a fluted aluminum radiator, and the muzzle blast of the gun was utilized to induce a draft of air through the radiation system. Chemical cooling has also been suggested. In 1897 Major Fitzgerald is said to have exhibited a machine gun in England for which he claimed novel cooling properties. According to accounts of the test, the breech of the gun was surrounded by a box, which was locked. Several hundred shots were fired, and the gun remained cool. The inventor refused to patent his device, and wanted to handle it as a secret. No one could be found to take a financial interest without first knowing what the device was, so that the invention finally passed into history.

The effort to reduce weight was somewhat more successful than the attempt to solve the cooling problem. The modern "heavy-type" guns, such as the Browning and Vickers, are but little more than half the weight of the early Maxims. The Browning weighs only 35 pounds, water jacket and all, including the water. However, the tripods weigh 40 pounds more, and the combination weighs 75 pounds. There is still room for improvement. Another result of the attempt to reduce weight was the production of guns of the type now known as the machine rifle. These guns weigh from 20 to 30 pounds, and are too heavy to be shot from the shoulder, and still do not have the steadiness or volume of fire that the heavy types do. Before the war, the tactics of automatic arms had not been worked out thoroughly enough clearly to differentiate between the uses of the different types of guns, and consequently any automatic weapon was a "machine gun." It was while affairs were at this stage that the Benet-Mercié was adopted as the machine gun of our service, and it was while affairs were still at this stage that the Lewis appeared as its rival. Both these weapons were of the machine rifle class, weighing from 27 to 30 pounds, and were used without a tripod. They were unsuitable for such work as overhead fire, barrage fire or indirect fire, though they had a usefulness in their own field.

Lessons of the War

A consideration of the question of the size and weight of machine guns brings us at once to a consideration of the lessons of the war, for one of the first things that the war taught us was the relation of the weight, mobility and steadiness of a gun to its tactical uses. Briefly, the needs of the war led to:

Tactical classification according to weight and mobility.

A demand for fire-control instruments and improved mounts.

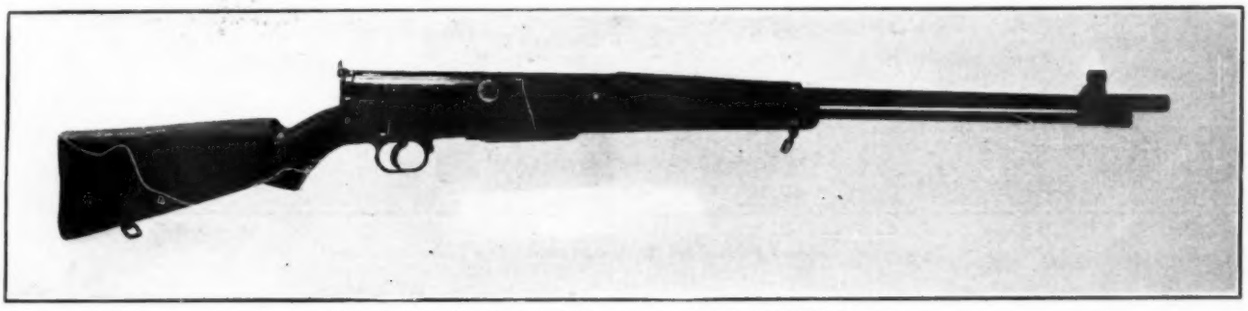
A desire for better ammunition.

An improved system of feeding ammunition to the guns.

The development of light automatic arms.

Special guns for special uses.

By the time the United States entered the war it had become well understood that one of the principal uses for machine guns was for barrage and indirect fire. Such a use for the machine gun called for a steady tripod which had provisions for accurately laying the gun and controlling its fire. It also called for a gun that could deliver a steady fire of many thousands of shots without interruption. For this use, guns of the Browning or Vickers class were eminently suitable. The machine rifle was useless for this work. This classification showed clearly the necessity for at least two types of automatic weapon, the heavy type for barrage and other such work, and a lighter type for direct fire. The British used the Lewis machine rifle, weighing about 26 pounds, as a light gun. France evolved a new weapon weighing 20 pounds to meet this special need. This was the chauchat, which was light enough to shoot from the shoulder. This was the first weapon used for "walking fire," in which the gun is fired from the hip, shot by shot, as the gunner advances. This weapon was given a new classification, that of automatic rifle. Immediately on our entrance into the war, the United States produced a still further improvement in this line, the Browning automatic rifle, weighing 15 pounds.



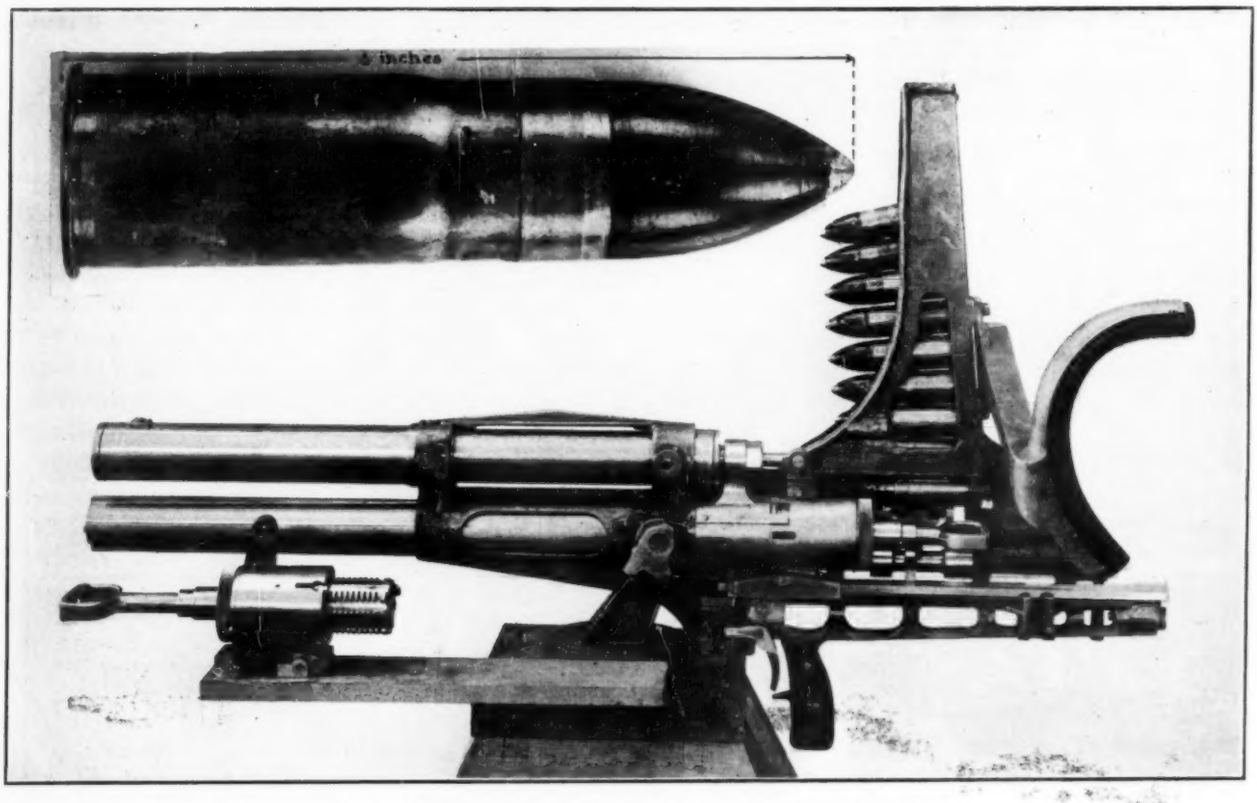
Improved semi-automatic rifle recently tested at Springfield Armory

The extensive use of barrage fire by our machine guns made it necessary to evolve a whole new system of fire-control instruments for machine-gun use. It also gave rise to an insistent call from our troops for a longer range ammunition. To meet this need, experiments were undertaken which resulted in increasing the range of our .30-caliber small-arms bullet from 3,150 meters to 6,000 meters. This result was accomplished by changing the form of the bullet so as to reduce its resistance to the air. Some years ago an improvement along these lines was made by giving the bullet a sharp point. The new change consisted in tapering the base of the bullet so as to allow the air to close in behind it.

Another improvement introduced by Army Ordnance during the war was in the system of supplying ammunition for machine guns. The cartridges must be fed to the guns in belts, and in the past it has been the practice to send the ammunition out to the field in clips of five for use in the shoulder rifle. Before the machine gun could be fired, the cartridges had to be taken out of the clips and loaded into the belts, then when the belts went through the guns they had to be picked up out of the mud and reloaded. The new system is entirely different. The cartridges for machine guns are packed in cheap belts at the factory, and the belts are sealed in stiff sheet-metal boxes. Then all that is necessary to fire the gun is to rip the cover off the box as you would off of a sardine can, and pull out the end of the belt and feed it to the gun. By this system the ammunition is at all times protected from dampness, mud and gas, as it is never opened until it is to be used. Owing to the elimination of the brass clips, this method of packing ammunition costs no more than the old way.

In addition to bringing out impovements in the regular types of machine gun, the war brought out many new designs for special purposes. One of these is the aircraft gun, mounted on the engine of the airplane and synchronized to shoot between the blades of the propeller. Another is the tank gun, with the interior mechanism of the heavy Browning, but with the rest of the gun modified for use in tanks.

The end of the war found the work of developing these improvements at the height of its activity. Like all other war work, most of this experimental development was discontinued at once. However, some of the projects seemed so important that the work was continued with a view to perfecting the contemplated improvements for future use. The work that is now being done with the lessons of the war still in mind is the work that will determine the characteristics of the machine gun of the near future. At the present



The Baldwin automatic cannon. Showing comparative size of cartridge

time the development work in machine-gun lines is looking toward the following results:

Improved ammunition.
Longer barrel life.
Heavier calibers for special purposes.
Special types of guns.
Lighter automatic rifles.

The improvement in ammunition has already been discussed. This work was started during the war, and was brought to a successful conclusion in 1919. While the results were obtained too late for use before the armistice, they will be of immense value in the future. The new ammunition which Army Ordnance has developed gives America perhaps the best small-arms bullet in the world, and nearly doubles the range of the machine gun, yet this result is accomplished without changing the outside shape of the cartridge and without making any change at all in the guns.

The question of improved barrel life for machine guns is an important one. At the present time a machine-gun barrel shoots out in a few thousand rounds. There is reason to believe that the resistance of machine-gun barrels to erosion can be greatly increased. Experiments looking to this result are now being conducted.

The development of a new high-power, large-caliber machine gun is another subject that is being pushed. During the war the desire to carry more incendiary material led to the adaptation of the old French 11-millimeter cartridge to our modern needs. While this cartridge had a large enough bullet to carry a lot of incendiary material it had the great drawback of not having velocity or penetration at all commensurate with modern high-power ammunition. The introduction of armored airplanes toward the end of the war pointed the need for some weapon for airplanes, more powerful than any now in use. To meet this need Army Ordnance started the development of the new high-power machine gun.

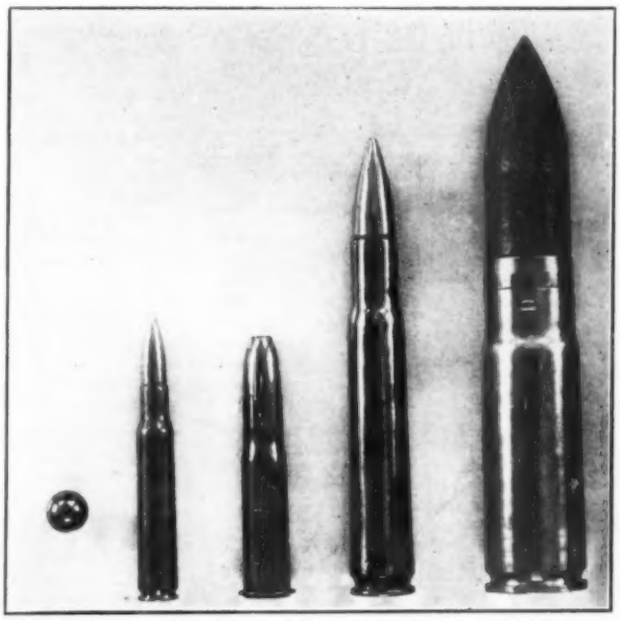
A comparison of its power with both the .30-caliber service cartridge and with the old 11-millimeter can be obtained from the accompanying photograph. When the new weapon is perfected, it will be considered both for arming aircraft and for special purposes on the ground, such as the attacking of tanks or the protection of observation balloons from attack by hostile aircraft. For airplanes use, such a gun would be synchronized to shoot through the propeller, and would use tracer and armor piercing ammunition for the attack of hostile aircraft. For use against enemy balloons, incendiary ammunition would be used. The large size of the bullet would enable an immense amount of incendiary material to be carried, and the large flaming bullets would quickly do for any balloon that might be struck. For use against tanks such a gun supplied with armor piercing ammunition should be very effective. The caliber of the new gun is to be

about half an inch. This means that the bullet will weigh about five times as much as the service bullet. This is a big advance in caliber, but a still greater advance is planned by the Ordnance Department, which is experimenting with a machine gun having a caliber of 1½ inches, or 37 millimeters. This gun, which is also intended for aircraft use, is called the Baldwin automatic cannon, and is remarkable for its small size and light weight when it is considered that it will handle the full cannon size 37 millimeter ammunition in both the armor-piereing and the high-explosive varieties.

Another tendency of modern design when applied to airplane guns is toward a gun that will fire very fast. The relative movement of two airplanes passing is so great that with ordinary speed of fire the opposing plane may fly between the bullets. To prevent this, the modern airplane machine gun is speeded up. The Browning aircraft gun was designed to fire at the rate of 1,200 shots per minute, about twice as fast as a ground gun.

A great deal of attention has been attracted in the newspapers lately by a new machine gun, said to be noiseless, flashless, generating no heat, and firing at the rate of 11,000 shots a minute, nearly twenty times as fast as the regular machine gun. Investigation shows that these accounts refer to a centrifugal machine gun now being tested at the Bureau of Standards in Washington. For years inventors have been attracted by the idea of using centrifugal force to project bullets, as a stone is thrown from a sling or as drops of water are thrown from the edge of a grindstone. In fact, the idea has been so popular that there are no less than 96 patents extant for different varieties of centrifugal gun. Perhaps the most promising of these devices is the one mentioned above. It is operated by either an electric motor or a gasoline engine, and requires about twenty-seven horsepower. Consequently it is not very mobile. It shoots a steel ball ½-inch in diameter, weighing 137 grains. When it is considered that the .50-caliber machine-gun bullet, which is the same diameter, weighs about 800 grains, or six times as much, it can be seen that the centrifugal gun will lack range, as its light bullet will not have the necessary weight to carry through against the air resistance, and will soon fall by the wayside, especially as it only goes with half the speed of the rifle bullet to start with. A further disadvantage of the centrifugal gun is the fact that its bullet is round and has no rifling to steady it in its flight. It rolls along one side of the barrel as it leaves the gun and gets a rotary motion at right angles to the axis of its flight, so that it curves as a baseball does. This fact, and the fact that it is hard to govern the delivery of the ball exactly, causes the accuracy of the gun to be very poor. In spite of its disadvantages, the centrifugal gun may find a place of usefulness on tanks or armored cars, where the engine is avilable to furnish power for it, or on airplanes. It might also be used for the defense of permanent works, when a power plant could be installed. Against large targets at short ranges, the device should be very effective. It certainly has the merit of using very simple and cheap ammunition.

There is another line of activity apparent now, which, while it does not involve the machine-gun proper, still deserves mention here because it promises an important extension in the use of automatic arms. This activity is in the direction of attempting to find a suitable semi-automatic shoulder rifle to replace the bolt-action rifle with which the soldier is at present armed. The development of such a weapon is not an easy task, for its mechanism must load and unload



Machine-gun cartridge (left to right): steel bullet for centrifugal gun; .30 caliber service cartridge; 11 mm. incendiary ammunition; cartridge for new .50 cal. machine gun; cartridge, 25 mm. automatic gun

the piece automatically, the same as a machine gun does, and at the same time the weight must be kept down to that of the ordinary Springfield rifle. That the Government considers this subject important is indicated by the fact that about a year ago an invitation was extended to manufacturers and inventors to participate in a test of self-loading rifles to be held at a future date. The test was recently held at Springfield Armory. Four rifles were submitted which approximated the Springfield rifle in weight, and all four shot well enough to indicate great possibilities along this line. The performance of these four rifles shows that the task of developing a suitable self-loading rifle, while it may be hard, is not impossible, and this fact, considered in the light of the great interest in this subject shown by the different war departments indicates that it is here that we should look for the important developments in the future of the automatic arm.

Extracts from Reports of Committee on Aims and Organization

March 27, 1920.

THE EXECUTIVE COUNSEL,
Army Ordnance Association.

GENTLEMEN:

Your Committee on Aims and Organization has determined a consensus of opinion as to the future activities of the Association and as to the most desirable means of achieving success in these fields as follows:

The two most important tasks now confronting the Association are:

(A) Increasing the present membership to approximately 10,000—the goal which was suggested by General McRoberts at the First Annual Meeting—and which apparently met with general approval.

(B) Organizing all members in such a manner as to enlist and maintain their individual interest in Ordnance to a degree which will hold them in the Associaton and make it a real factor in National Preparedness.

(A) INCREASE OF MEMBERSHIP.

The *desirability* of increasing the present membership arises from two causes:

(1) The obvious advantage of developing the Association to the greatest possible degree as representative of American science, engineering and industry, in relation to Ordnance.

(2) The duty devolving upon any Association of National scope to make a thorough canvass of its eligibles in order to insure that all are invited to join in the furtherance of its avowed purpose.

The *necessity of* increasing the present membership arises from the fact that any organization to be successful in its purpose must be financially stable.

Granting that the membership should be increased sufficiently to decrease the percentage of overhead expense, there appear to be two methods of accomplishing this:

(*a*) By direct solicitation by letter from the Secretary to eligibles all over the country.

(*b*) By decentralizing this solicitation; *i. e.*, by utilizing the twelve Ordnance Districts formed during the war, as the basis for District recruting drives.

Nearly 14,000 circular letters were sent out from the Secretary's office to yield the first 1,000 members. On the same basis, about 100,000 additional letters would be required even if additional names were readily available, which they are not. That the decentralization of recruiting is the more practicable method seems obvious, and steps to increase membership along these lines have already been taken in several Districts.

All things considered, it is believed to be advisable to utilize the Ordnance Districts as bases for recruiting new members and passing upon their applications, as well as for local social gatherings, the election of District Representatives, etc. The allocation of Association funds for these purposes is considered proper and necessary authority therefor should be embodied in the By-Laws.

(B) MAINTAINING INTEREST OF INDIVIDUAL MEMBERS.

The paramount problem is to *get new* members, but to *hold all* members in the Association is of but slightly less importance. The maximum influence of the Association can not be developed unless measures are adopted which will keep its members in touch with the peace-time problems of the U. S. Army Ordnance Department along lines appealing to the *interests of individual* members.

The subject of Ordnance is so broad that while *general* interest may be developed and suitably maintaind by an annual meeting at Aberdeen and by periodic smaller special meetings or correspondence on interesting subjects, participated in by the members of the Association and the Executive Council representing geographical districts, these forms of activity and contact lack the necessary degre of *individual interest* in particular phases of problems connected with the development, etc., of Ordnance materiel, which would be obtainable from *individual members* of the Association if grouped within divisions and sections along "subjective" lines, viz., under the several main items in the list of Ordnance materiel, with an additional division to comprise members interested in the various Field Service activities.

In order to put this form of organization into effect, it will only be necessary that members be requested to signify their particular interest in one or more of the six major divisions of the general subject of Ordnance, as determined in the organzation of the Office of the Chief of Ordnance of the U. S. Army, viz.:

(*a*) Aircraft Armament, including—
- Aerial Bombs,
- Aircraft Machine Guns.

(*b*) Small Arms, including—
- Small Arms Ammunition,
- Automatic Rifles and Machine Guns,
- Shoulder Rifles,
- Personal Equipment (Pistols, Revolvers, etc.).

(*c*) Ammunition (other than for Small Arms and Machine Guns), including—
- Explosives,
- Metal Components,
- Loading.

(*d*) Artillery, including—
- Fire Control Instruments,
- Cannon,
- Mobile Gun Carriages,
- Railway and Seacoast Gun Carriages.

(*e*) Motorized Ordnance, including—
- Tanks,
- Tractors,
- Trailers.

(*f*) Ordnance Field Service, including—
- Storage of Explosives,
- General Warehousing,
- Maintenance of Ordnance.

On receipt of answers to suitable questionnaires, there can be organized six Divisions of the Association paralleling Divisions of the same name (and the Field Service) in the Ordnance Office. As soon as practicable, members comprising these Divisions can then proceed to elect Division Chairmen who would be expected to keep in close contact with the Chiefs of the corresponding Divisions of the Office of the Chief of Ordnance, and who would be consulted by those officers on questions of general policy, design and procedure arising from the peace-time problems encountred by their Division from time to time.

It seems probable that it will later be found advisable again to divide these "subjective" Divisions of the Association into Sections corresponding to the Sections respectively comprising the five Divisions (and Field Service) of the Ordnance Office, these Sections to be represented by Section Chairmen who would be expected to keep in close contact with the Chief of the Ordnance Office Section handling matters pertaining to the subjects in which they are mutually interested.

In this manner it ought to be possible to bring the best trained minds of the industries and engineering professions in this country into close and continuing contact with the proper officials of the Army Ordnance Department to the obvious advantage of both, as a result of free interchange of ideas and practical co-operation. For instance, the Chief of the Small Arms Ammunition Section of the Small Arms Division of the Ordnance Department, through the Association, would be brought in touch with engineers, executives and production men of all manufacturers of small-arms ammunition in the United States. The commercial mind would gain an insight into the trend of development of this material and the miltary mind would constantly take into account whether or not new designs were capable of economical quantity manufacture within a reasonable length of time. Drawings, specifications and manufacturing processes would all be adjusted in the calmer atmosphere of peace, so as to yield in the event of war the maximum effectiveness from the military point of view combined with maximum facility for manufacture from an industral point of view.

RECOMMENDATIONS.

Accordingly, your Committee recommends—

(A) That an active campaign for increased membership be immediately inaugurated in each of the Ordnance Districts with the object of obtaining a total membership of 10,000 at the earliest practicable date. (Allocation of active memberships to be made to the various districts on the basis of potential munition producing power.)

(B) That allocation of the Association funds for this purpose be approved in principle by the Executive Council, actual disbursements to be made by the Treasurer on vouchers submitted for each District by the Secretary of the Association in conjunction with the Executive Council member representing the District or a Membership Committee operating under his supervision.

(C) That the Secretary of the Association be instructed to proceed with the organization of the Association along "Subjective" lines as outlined hereinbefore.

(D) That the Association frankly recognize that it is still in its formative stage, and accordingly consider as Charter Members all new members who join prior to August 31, 1920.

(E) That election of the President, and the two Vice-Presidents be postponed until a thorough canvass of eligibles for membership has been made in all Districts, but that this

election be held sufficiently prior to the next annual meeting to permit the inauguration of the first Officers of the Association at that time.

(F) That subjects of general interest to the entire Association and the Ordnance Department of the U. S. Army be handled by Special Committees of the Association in conjunction with Officers or Boards of Officers appointed by the Chief of Ordnance of the U. S. Army, for instance—one of the first tasks of the Association should be an attempt to formulate and recommend for adoption types of uniform contracts which would be mutually satisfactory to private manufacturers and to the Government, and also standard rules and regulations for cost accounting, etc., under such of these various types of contracts as may involve determination of costs in computing or establishing compensation.

(G) That Standing Committees of the Association should be inaugurated to co-operate with committees from other technical societies, such as the Society of Automotive Engineers, the American Socety of Mechanical Engineers, the American Institute of Electrical Engineers, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers and other national bodies, also with the Technical Staff of the Ordnance Department, on all technical problems involving, as a whole, the Ordnance Department of the U. S. Army.

THE JUNE COUNCIL MEETING.

THE EXECUTIVE COUNCIL,

Army Ordnance Association.

GENTLEMEN:

The first report of your Committee on Aims and Organization submitted to the Secretary on March 27, 1920, was based fundamentally upon the assumption that the Association membership could be increased to an extent yielding an income, from membership dues as fixed at present, which would permit the employment of a Secretary on a full-time basis and also furnish him with ample clerical assistance and office facilities. The prospective income will not, however, permit the very desirable, but to a certain extent complicated form of organization for the Association proposed in the original report.

In view of this, it seemed advisable to the Committee on Aims and Organization, four members of which were present at the meeting, to withdraw the Committee's first report and to modify certain provisions therein with the idea of reducing the cost of administration of Association activities.

At the same meeting, Counsel for the Association was instructed to take necessary steps to have the Association incorporated. Accordingly, the Constitution has been so framed as to permit the Board of Directors of the Corporation and the governing body of the Association to be comprised of the same individuals if desired. The designation "Executive Council" has therefore been changed to "Board of Directors," and the number has been reduced to six. It is believed that this number will permit the Nominating Committee to choose Directors representing the following grouped, territorial Districts: Boston and Bridgeport; New York City and Rochester; Philadelphia and Pittsburgh; Cincinnati and Baltimore; Cleveland and Detroit; Chicago and St. Louis; and also to select these Directors with a view to their particular interest in the major divisions of the general subject of Ordnance, as determined by the organization of the Office of the Chief of Ordnance, U. S. Army, viz., Small Arms; Aircraft Armament; Ammunition; Field Service; Motorized Ordnance; Artillery. The reduced number of Directors will also permit the Association to pay traveling expenses for attendance at Directors' Meetings with greater prospect of insuring full attendance.

The number of Vice-Presidents has been reduced from two to one, and the President assigned in the By-Laws to supervision of the District Activities of the Association; the Vice-President being assigned to supervision of Divisional Activities of the Association. The organization of Association membership into Districts and Divisions has been made permissive instead of mandatory in the By-Laws with the idea that when the need for subdivision along these lines is manifested spontaneously, ample authority will be given for expenditure of funds for these purposes, and yet avoid the necessity of unprofitable employment of the Secretary's time in endeavoring to carry out provisions of the By-Laws before the time is ripe for a highly articulated organization of the Association.

Membership dues have been fixed at $5.00 per year, payable in advance, omitting any reference to a definite date when the dues of the entire membership would fall due. It is believed that this will reduce the expense of administration by relieving a peak-load about October 1, as would presumably occur under the original provisions making all dues payable on that date.

Subject to the above modifications, the Committee on Aims and Organization resubmits herewith its first report dated March 27, 1920, together with the Constitution for the Association, redrafted in accordance with the latest recommendations of the Committee, and By-Laws in extension of the Constitution, all for the consideration of the Executive Council.

Respectfully submitted.

W. C. SPRUANCE,
Chairman,
C. A. PATTERSON,
BASCOM LITTLE,
RALPH CREWS,
J. H. VAN DEVENTER.

[NOTE.—The above reports were accepted by the Executive Council at the meeting held in New York City, June 9, 1920, and the Secretary was instructed to submit the Constitution and By-Laws inclosed with the Report to the entire membership for ratification.]

Constitution and By-Laws, Army Ordnance Association

ARTICLE I.
Name.

The name of the organization shall be the ARMY ORDNANCE ASSOCIATION of the United States of America.

ARTICLE II.
Purpose.

The purpose of this association shall be:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation between American Scientists, Inventors, Engineers, and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects.

ARTICLE III.
Membership.

The membership of this association shall consist of active members and honorary members, to be elected in accordance with the By-Laws of the association.

American Citizens not in the employ of the United States Government who have held positions of responsibility in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance during the World War, or who occupy positions in civil life which would render them available for assisting in the production of Ordnance in the event of war shall be eligible for active membership.

American Citizens having similar qualifications to those required for active members but who are in the employ of the United States Government shall be eligible for honorary membership only.

Honorary membership shall have the same rights and privileges as active members and be subject to the same dues, but shall not be eligible to hold elective office nor be entitled to a ballot. Honorary members shall automatically become active members on leaving Government employ; and vice versa, active members shall automatically become honorary members on entering Government employ.

ARTICLE IV.
Officers.

The officers of this association shall be a President, a Vice-President, a Counsel, a Treasurer and a Secretary.

ARTICLE V.

The Board of Directors.

The Board of Directors shall consist of the President, who shall be ex-officio Chairman; the past President of the previous year, the Vice-President and six Directors.

The Board of Directors shall prepare By-Laws governing this association which, when approved by a majority of the membership, shall become effective;

Shall have full control of the activities of this association, subject to the limitations of the Constitution and such By-Laws as may be adopted thereunder;

Shall have the power to fill casual vacancies in its membership by appointment for the unexpired portion of the term, and original vacancies until practicable to hold elections.

ARTICLE VI.

Elections and Appointments.

The President, Vice-President, and Directors shall be elected by letter ballot of the entire active membership and shall hold office: the President and the Vice-President, for one year, and the Directors for two years, the term of one-half terminating in the odd years and of the other half terminating in the even years.

The Treasurer shall be appointed by the Board of Directors for a term of two years.

Counsel for the association shall be appointed by the Board of Directors for such purposes and for such periods as may be deemed desirable from time to time.

The Secretary shall be appointed by the Board of Directors for a term of one year and may receive a salary fixed by the Board.

ARTICLE VII.

Membership Dues.

The annual dues for membership in this association shall be five dollars per year, payable in advance.

ARTICLE VIII.

Annual Meeting.

The annual meeting of the association shall be held during the first week of October in each year, and shall be utilized for the inauguration of officers for the ensuring year, for the discussion of new and improved methods of manufacture, and for the demonstration of such experimental types of ordnance material as may be authorized by the War Department.

ARTICLE IX.

Amendments to this constitution shall be submitted to the entire active membership for approval and shall be adopted if a majority of votes cast is in favor thereof.

Amendments to By-Laws in conformity with this Constitution shall become effective on approval by a majority of the members of the Board of Directors.

BY-LAWS OF THE ARMY ORDNANCE ASSOCIATION.

Calendar.

1. The fiscal year of this Association shall close on September 30th of each year.

2. The yearly calendar shall be as nearly as practicable as follows:

June 1 (on or before)—
Nominating Committee appointed.
July 15 (on or before)—
Nominating Committee submits report of nominees to Secretary.
July 31 (on or before)—
Secretary sends out letter ballots for officers.
July 31 (on or before)—
President appoints tellers of election.
September (first Tuesday)—
Polls close at noon.
September 15 (on or before)—
Tellers report results of election to Board of Directors.
September 30—
Fiscal year closes.
October (first Friday)—
Annual Meeting opens, inauguration of officers for ensuing year.

3. The insignia of membership approved by the Board of Directors shall be issued gratis to all members. The official stationery shall be used only by Officers and Directors of the Association and officers of Districts, Divisions and Committees of the Association.

4. Three dollars of the membership dues—five dollars—shall be devoted to an annual subscription to ARMY ORDNANCE, the official journal of the Association.

Charter Members.

5. The list of charter members of this Association shall be considered closed as of September 30, 1920.

Organization of Membership Districts of the Association.

6. For the purpose of recruiting new members, passing upon applications for membership, and conducting local meetings for professional or social purposes, the active membership may be divided according to domicile into geographical Districts corresponding generally to the industrial districts established during the World War to facilitate the production of Ordnance.

7. Each District may elect a District Chairman from among the active members residing within the geographical limits of said District. Pending said election, the Board of Directors may, at its discretion, appoint a District Chairman from among the active members resident in the District being organized. The District Chairman may appoint a District Executive Committee of five members and District Secretary, who may be paid a salary fixed by the District Executive Committee from such funds as may be allocated for District activities by the Board of Directors of the Association, or from such funds in addition to annual dues for membership in the Association as may be contributed by the District membership to be applied to purely local District activities.

8. *District Activities.*—The principal activities of a District shall be to make a thorough canvass for desirable and eligible personnel for membership in the Association; to form a District organization similar to that which existed during the World War; to assist the District Chairman in familiarizing himself with the personnel, equipment and financial resources of firms within the District able to produce Ordnance material, in order that he may be in a position to furnish this information promptly to the Army Ordnance Department in an emergency; to stimulate interest in the subject of Ordnance in general and the activities of Ordnance establishments within the District in particular by means of meetings for the presentation and discussion of papers relating to the design and production of Ordnance material; and also to hold meetings for purely social purposes.

9. *Co-operation of Districts.*—A District may arrange to hold joint meetings with other local organizations of similar purpose, and may invite members of such organizations to attend its meetings. A District may affiliate with existing local engineering organizations or patriotic societies or form jointly with them new local organizations, but the plan of such affiliation or organization and the obligations assumed by the District and the Association thereby shall first be approved by the Board of Directors of the Association.

10. *District Representatives.*—The District Chairman shall represent the District at meetings of the Board of Directors and shall be entitled to a vote on all matters affecting District activities. In the event that he is unable to attend, he may designate a member of the local District Executive Committee to appear in his stead. Said designation shall be in writing and shall be considered as granting complete authority of action during the current session unless otherwise stated in the letter of designation.

11. *District Delegates.*—Each District shall have the privilege of representation at the Annual Meeting of the Association by one official Delegate in case the District Chairman is for any reason unable to attend. The Chairman or Delegate may have such portion of his traveling expenses in attending the meeting refunded by the Association as the Committee on Ordnance Districts may direct.

12. *Management of Districts.*—Districts shall be managed in conformity with the Constitution, By-Laws and Rules of the Association, by the District Executive Committee acting through the Chairman, Secretary and such other officers as may be found desirable. Each District Chairman shall receive notices and have the privilege of attending all meetings of the Committee on District activities. Each District Secretary shall report the proceedings of that District to the Secretary of the Association. He shall discharge the duties of the Secretary of the District and shall perform such other duties as may be prescribed by the District Executive Committee.

13. *Appropriation for District Activities.*—Appropriations by the Board of Directors for District activities shall be used only for

expenses incurred in connection with legitimate District activities.

14. Expenditures chargeable to the Association for purposes of any District activity must be provided for in the annual budget approved by the Board of Directors. No liability otherwise incurred shall be binding upon the Association.

15. An allotment for a District may be drawn on by its Executive Committee as desired, provided that not more than one-half of the total yearly allotment shall be drawn between October 1st and April 1st, and that an itemized account of expenditures during that period shall be rendered to the Treasurer of the Association before the remaining amount of the appropriation can be drawn, and provided also, that the remainder of the allotment shall be drawn only during the remaining half of the fiscal year, and that an accounting of the second half shall be rendered within 30 days of the end of the fiscal year.

16. *Stationery for Districts.*—All Districts shall use only such uniform stationery as shall be supplied or approved by the Secretary of the Association.

Divisions of the Association.

17. For the purpose of enlisting the individual interest of members in the particular problems of the Army Ordnance Department with which they are the most familiar, or with which they desire to become familiar, the active membership may be grouped into Divisions corresponding to the several major divisions of the subject of Ordnance as determined by the organization of the Office of the Chief of Ordnance, U. S. Army, such as:

(*a*) Aircraft Armament, including Aerial Bombs, Aircraft Machine Guns.

(*b*) Small Arms, including Small Arms Munition, Automatic Rifles and Machine Guns, Shoulder Rifles, Personal Equipment (Pistols, Revolvers, etc.).

(*c*) Ammunition (other than for Small Arms and Machine Guns), including Explosives, Metal Components, Loading.

(*d*) Artillery, including Fire Control Instruments, Cannon, Mobile Gun Carriages, Railway and Seacoast Gun Carriages.

(*e*) Motorized Ordnance, including Tanks, Tractors, Trailers.

(*f*) Ordnance Field Service, including Storage of Explosives, General Warehousing, Maintenance of Ordnance.

18. All active members shall be requested by the Secretary to signify their interest in one or more of the major divisions of the subject of Ordnance as outlined above, and, with their consent, shall be assigned to membership in appropriate Divisions of the Association.

19. The Secretary of the Association shall keep posted to date complete rosters of Division memberships, and on request of one-third of any Division membership, shall arrange for the election of a Division Chairman by letter ballot of said Division memberships. Pending said election, the Board of Directors, may at its discretion, appoint a Division Chairman from among the active members of the Division being organized.

20. Each Division Chairman may appoint a Division Executive Committee of five members and a Division Secretary who may be paid a salary fixed by the Division Executive Committee from such funds as may be allocated for Divisional Activities by the Board of Directors of the Association.

21. *Division Representatives.*—The Division Chairman shall represent the Division at meetings of the Board of Directors, and shall be entitled to a vote on all matters affecting Division activities, but, in the event that he is unable to attend a meeting, he may designate a member of the Division Executive Committee to appear in his stead. Said designation shall be in writing, and shall be considered as granting full authority of action during the current session unless otherwise stated in the letter of designation.

22. *Division Activities.*—The principal activity of a Division of the Associaton shall be the consideration of engineering, scientific, or manufacturing subjects or problems connected with or which may arise in connection with the design or manufacture of that class of Ordnance material in which the Division membership has signified its particular interest.

23. The provisions of the Constitution, By-Laws and Rules of the Association, and the precedents of the Association with respect to professional sessions for the discussion of papers, shall cover the procedure of the Divisions except that no meeting of a Division shall be considered a meeting of the Association as a whole.

24. For the convenient conduct of its affairs the Division may organize sections corresponding to the Sections into which the parallel Division of the Office of the Chief of Ordnance is divided. Such officers as these Sections shall require must be selected from the membership of the Section. Special Committees of the Division shall be appointed by the Division Executive Chairman.

25. The Division Executive Committee shall through the Division Secretary keep in close touch with the Chief of the corresponding Division of the Ordnance Office, and shall arrange for the distribution of such informative matter to members of the Division as may be received from time to time.

26. Expenditures for Divisional activities chargeable to the Association must be authorized by the Board of Directors before they are incurred, and must be provided for in the budget approved by the Board of Directors. No liability otherwise incurred shall be binding upon the Association. Any expenditure not so provided for must be met by the Division itself.

Duties of Officers.

27. *Duties of Officers.*—The President, Treasurer and Secretary of the Association shall perform the duties legally or customarily attaching to their respective offices under the laws of the United States and of the State in which its principal office is located, and such other duties as may be required of them by the Board of Directors.

28. A vacancy in the office of President shall be filled by the Vice-President.

29. The President shall supervise and coordinate District Activities of the Association. He shall be ex-officio Chairman of the Committee on District Activities. He shall consult frequently with the Chief of Ordnance or such other officer of the Army Ordnance Department as may be placed by the Chief of Ordnance in charge of the industrial mobilization of the country for the manufacture of Ordnance.

30. The Vice-President shall supervise and co-ordinate the Divisional Activities of the Association. He shall be ex-officio Chairman of the Committee on Divisional Activities, and shall be consulted by the President as to its proper membership. He shall consult frequently with the Chief of Manufacture or such other officer of the Army Ordnance Department as may be placed by the Chief of Ordnance in charge of the general manufacturing and production activities of the Ordnance Department.

31. The Treasurer shall, under the supervision of the Committee on Finance, have charge of the books of account of the Association; shall collect all bills against members or others; shall have charge of all bills against the Association, shall keep an account of the same, and shall present them in proper form to the Committee on Finance for audit; shall make payments only on the certificate of the Secretary, acting in accordance with the directions of the Board of Directors.

32. All funds received by any person for the Association shall be delivered to the Treasurer. He shall immediately deposit such funds as he receives, to the credit of the Association, in a bank to be designated by the Board of Directors.

33. Directions for the conduct of the business affairs of the Association may be established by the Secretary in conjunction with the Treasurer and the work covered shall be carried out as provided by these directions.

34. The Secretary of the Association shall be the Secretary of the Board of Directors, and also of each of the Standing Committees.

The Board of Directors.

35. The number of persons constituting a quorum of the Board of Directors shall be a majority of its members.

36. The Board of Directors, at its first meeting in each fiscal year (October 1st to September 30, inclusive), shall consider the recommendations of the Commiitee on Finance concerning the expenditures necessary for the work of the Association during the ensuing year. The apportioning of the work of the Association among the various Standing and other Committees shall be on a basis approved by the Board of Directors and in harmony with the Constitution and By-Laws. The appropriations approved by the Board of Directors, or so much thereof as may be required for the work of the Association, shall be expended by the Treasurer on vouchers prepared by the Secretary, under the direction of the various Committees of the Association, and all bills against the Association and for such expenditure shall be certified as correct and just by the Secretary, and as having been paid by the Treasurer, and shall then be sent to the Finance Committee for audit.

Elections.

37. A Nominating Committee of five members shall be appointed before June 1st of each year by the President, or pending the election of the first Prsident, by the Founding Committee. This Committee shall deliver to the Secretary in writing between the 1st and 15th of July the names of its nominees for the various elective offices next falling vacant under the Constitution, together with the written consent of each nominee.

38. The Secretary shall mail on or before July 31st of each year to each member entitled to vote a ballot stating the names of the candidates for the several offices falling vacant, and the time of the closure of the voting. The voter shall prepare his ballot by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Association. The voter shall enclose ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second envelope marked "Ballot for Officers," seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Secretary of the Association.

Tellers.

39. The President shall, on or before July 31, of each year, appoint three tellers of Election of Officers, whose duty shall be to canvass the votes cast, and certify the same to the President or Presiding Officer at the first subsequent session of the Board of Directors.

The term of office of the Tellers shall expire when their report of the canvass has been presented and accepted.

40. The Secretary shall certify to the competency and signature of all voters, and shall deliver unopened all ballots to the Tellers of Election. Ballots without the autographic endorsement of the voter written on the outside envelope are defective. Ballots which contain more names than there are offices to be filled are thereby defective, and shall be rejected by the Tellers of Election.

41. The voting for the election of officers shall close at 12 noon on the first Tuesday in September in each year. The Tellers shall not receive any ballot after the stated time for the closing of the voting. The Tellers of Election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President or Presiding Officer at the next succeeding session of the Board of Directors of the Association. The President or Presiding Officer shall then announce the candidates having the greatest number of votes for their respective offices, and declare them elected for the ensuing year.

42. The names of the candidates proposed by the Nominating Committee or Committees, and the respective offices for which they are candidates, shall be printed in separate lists on the same ballot sheet.

43. In case of a tie in the vote for any officer, the President or, in his absence, the Presiding Officer of the Board of Directors, shall cast the deciding vote.

Meetings.

44. The Annual Meeting shall be held at the Aberdeen Proving Ground, Maryland, on the first Friday in October and continue from day to day as the Board of Directors may direct.

45. Special Meetings of the Association may be called at any time at the discretion of the Board of Directors, or shall be called by the President upon the written request of fifty persons entitled to vote, the notices for such meetings to state the business for which such meeting is called and no other business shall be entertained or transacted at that meeting.

46. Professional Meetings of the Association (as distinguished from such meetings held by Districts or Divisions), for the reading and discussion of papers and for topical discussions may be held at such times and places as the Board of Directors may direct.

47. A notice of each Annual or Special Meeting shall be mailed by the Secretary to each member not less than thirty days before the date of that meeting.

48. The expenses of all meetings of the Association and of any District, Division, or section thereof, shall be arranged in accordance with the By-Laws and such Rules as the Board of Directors may from time to time adopt: *Provided, however,* that nothing in this section shall be construed to authorize the Board of Directors to make any increase in the annual dues of members of the Association.

Amendments to the Constitution.

49. At any Annual Meeting of the Association any voting member may propose in writing an amendment to the Constitution. Such proposed amendment, if duly seconded by a voting member, shall be open to discussion and to such modification as may be accepted; and shall within 60 days be submitted by letter ballot to all members entitled to vote: *Provided*, that 20 votes are cast in favor of such submission.

50. Ballots for an amendment to the Constitution shall be canvassed and announced in the same manner as the ballots for officers of the Association. The President shall appoint three Tellers to canvass any letter-ballots which shall be ordered by the Board of Directors or by the Association and to certify the same to the President or Presiding Officer of the Board of Directors at its next subsequent meeting.

51. Thirty days after the date on which the ballots are mailed to the voting membership, the ballots returned shall be counted by Tellers appointed as provided in the By-Laws. The Tellers shall announce immediately the result of the vote, which shall be mailed to the members by the Secretary. The adoption of the amendment shall be decided by a majority of the votes cast.

52. An Amendment shall take effect immediately upon the announcement of its adoption.

Amendments to By-Laws.

53. For the further ordering of the affairs of the Association, the Board of Directors may, by a majority vote of its members, amend the By-Laws in harmony with the Constitution, *provided* that the Secretary shall have mailed to each member of the Board a copy of such proposed amendment, at least ten days in advance of the meeting of the Board at which action is to be taken, and, *provided further*, that members unable to be present may signify their approval or disapproval by letter to the Secretary, which letters shall be read by him to the members present prior to balloting, and shall constitute the vote of the absent members on the amendment under discussion. The amendment shall take effect immediately on its passage by the Board of Directors. Such amendments shall be announced in the next regular publication of the Association.

Rules.

54. The Board of Directors may, by a majority vote of the members present at any meeting, establish, amend, or annul Rules for the conduct of the business affairs of the Association; for the ordering and conduct of its professional or business meetings; and for the guidance of its committees in their work and reports—*provided* that such Rules are in harmony with the Constitution and By-Laws of the Association.

Committees.

55. The Standing Committees of the Association shall be:

Committee on Aims and Organization.
Committee on Finance.
Committee on Meetings and Program.
Committee on Divisional Activities.
Committee on District Activities.
Committee on Standardization.

56. The appointment, organization, duties and terms of service of these standing committees shall be as the By-Laws provide. The Chairmen of each Standing Committee shall have a seat in the Board of Directors of the Association but no vote.

57. The President within one month after the Annual Meeting shall fill all vacancies in the Standing Committees by appointment from the membership of the Association.

58. Each of the Standing Committees shall, at their first meeting after the Annual Meeting, elect a Chairman to serve for one year, unless a Chairman ex-officio is provided for in these By-Laws. A member of a Standing Committee, whose term of office has expired, shall continue to serve until his successor shall have been appointed.

59. Written reports of all committees shall be presented to the Board of Directors. Each written report of every Committee must be approved in writing by at least a majority of the members of that Committee, before it is presented to the Board. A member of a Committee who disagrees with the action of a majority of that Committee may express his disagreement over his signature, either on the report of the Committee or in a minority report. The minority report of any member or members of a Committee if offered, shall be presented at the same time that the report of that Committee is presented to the Board.

60. All reports of Committees must be first received by the Board of Directors, who shall prescribe the manner in which they shall be presented to the Membership of the Association or be made public and printed.

Committee on Aims and Organization.

61. The Committee on Aims and Organization shall consist of five persons who shall be members of the Association. The term of office of one member of the Committee shall expire at the close of each Annual Meeting.

62. It shall be the duty of the Committee to consider and report on all matters relating to the Constitution, By-Laws, Rules and Publications of the Association which may be referred to it; and to investigate and report upon desirable activities which the Association can legitimately engage in under the Constitution, and to devise ways and means for accomplishing objectives determined upon by the Board of Directors.

Committee on Finance.

63. The Committee on Finance shall consist of five members eligible to hold office. The term of office of one member of the Committee shall expire at the close of each Annual Meeting.

64. This Committee shall, under the direction of the Board of Directors, have supervision of the financial affairs of the Association, including the books of account. The Committee may cause the accounts of the Association to be audited and approved annually by a chartered or other competent public accountant. The Committee shall hold annual meetings for the audit of bills and such other business as shall come before it and shall deliver to the Secretary for presentation to the Council at the end of each fiscal year, a report of the financial condition of the Association for the past year, and also shall present therewith a detailed estimate of the probable income and expenditure of the Association for the ensuing twelve months. It shall make recommendations to the Board, advise upon financial questions. It shall have charge of the making of all contracts and other obligations to pay money in the Association's work and the ordering of all expenditures in excess of $100 thereunder.

Committee on Meetings and Program.

65. The Committee on Meetings and Program shall consist of five persons, who shall be members of the Association.

66. It shall be the duty of the Committee to procure professional papers, to pass upon their suitability for presentation or publication, and to suggest typical subjects for discussion at the Annual Meeting. The Committee may refer any paper presented to the Association to a person or persons, especially qualified by theoretical knowledge or practical experience, for their suggestions or opinions as to the suitability of the paper for presentation or publication.

67. The Committee shall arrange the program, and shall have general charge of the entertainment to be provided for the members and guests for the above meetings. It may prohibit the distribution or exhibition at the headquarters or at the places of the above meetings of all advertising circulars, pamphlets or samples of commercial apparatus or machinery. At the end of each fiscal year, the Committee shall deliver to the Secretary for

presentation to the Board of Directors a detailed report of its work.

Committee on Divisional Activities.

68. The Committee on Divisional Activities shall consist of five members of the Association, not more than one of whom shall be selected from the same Division. The term of office of one member of the Committe shall expire at the close of each annual meeting.

69. It shall be the duty of this committee:

To devise ways and means for enlisting and maintaining the individual interest of members of the Association in some particular phase of the design and manufacture of Ordnance as determined by the organization of the Office of the Chief of Ordnance, U. S. Army.

To devise ways and means to keep possible manufacturers of various types of Ordnance material in close touch with the Divisions of the Office of the Chief of Ordnance charged with the design and manufacture of these types.

To confer with the officers and members of the Divisions of the Association and to consider, and make recommendations to the Board of Directors upon all matters affecting these Divisions.

To confer with the Committee on Finance as to the appropriation for the expenses of Divisions of the Association in each annual budget of the Association and to determine the portion of that appropriation which shall be alloted to each Division.

Committee on District Activities.

70. The Committee on District Activities shall consist of five members, of the Association, eligible to hold office, not more than one of whom shall be selected from the same District. The term of office of one member of the Committee shall expire at the close of each annual meeting.

71. It shall be the duty of this Committee:

To determine the qualifications for membership in this Association and to draw up rules and regulations for admission of members in conformity thereto.

To survey the field for eligibles for member ship and devise ways and means for interesting them in the work of the Association, with a view to securing their applications for membership.

To confer with the officers and members of Districts and to consider, and make recommendations to the Board of Directors upon all matters affecting the welfare of the Districts.

To confer with the Committee on Finance as to the appropriation for the expenses of the Districts in each annual budget of the Association, and to determine the portion of that appropriation which shall be allotted to each District.

Committee on Standardization.

72. There shall be a Committee on Standardization to consist of five members of the Association. The term of office of one member of the Committee shall expire at the close of each Annual Meeting.

73. It shall be the duty of this Committee:

To formulate and recommend standards of principle, and method of procedure in the design, inspection and production of Ordnance, including the drafting of uniform types of contracts as basis for negotiation and the formulation of standard rules for cost accounting for such contracts as involve the determination of cost.

To co-operate with like committees of bodies of kindred aims, or with the members of the Association, in the formulation and revision of standards; or to appoint under approval of the Board of Directors, committees of experts in specialized subjects to co-operate with them. The Chairman may represent the Committee on Standardization in any conferences.

To report to the Board of Directors with its recommendations for any formulated standards for its approval, and when approved to present and recommend such standards to the meetings of the Association, and secure their promulgation by publication in the press or otherwise.

Please clip this Ballot on the black lines. Insert it in a plain envelope marked Ballot. Then insert this envelope in a second one, *sign your name* in the upper left-hand corner, and mail before September 7, 1920.

SECRETARY, ARMY ORDNANCE ASSOCIATION,
Room 410 Munsey Building,
Washington, D. C.

BALLOT—Polls close Tuesday, Sept. 7, 1920, at Noon

Par. 38 By-Laws A. O. A. . . . The voter shall prepare his ballot by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Association. The voter shall enclose ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second envelope marked "Ballot for Officers," seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Secretary of the Association.

FOR PRESIDENT—Vote for one

BENEDICT CROWELL

FOR VICE-PRESIDENT—Vote for one

W. W. COLEMAN

FOR DIRECTORS—Vote for six.

(For One Year)	(For Two Years)
SAMUEL McROBERTS	ROBERT P. LAMONT
GUY E. TRIPP	C. L. HARRISON
WALDO C. BRYANT	FRANK A. SCOTT
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I hereby ratify the Constitution and By-Laws of the Army Ordnance Association as published in full in the July-August number of ARMY ORDNANCE, and authorize the Treasurer to charge my account at the rate of $3.00 per year, from my membership due of $5.00 per year already paid or to be paid, as payment in full for subscription to ARMY ORDNANCE for the unexpired portion of my paid-up membership.

Cut Ballot on This line.

BRING IN A MEMBER—MAKE THIS COUPON PRODUCTIVE

Date----------

THE SECRETARY, Army Ordnance Association
Munsey Building, Washington, D. C.

I desire to enroll as a Charter Member of the ARMY ORDNANCE ASSOCIATION, and enclose check for $5 to cover all organization assessments, initiation fee, official insignia, and annual dues for one year from date. Of this amount, I authorize the Treasurer to allot $3 to cover annual subscription to ARMY ORDNANCE—the official journal of the Association.

Name----------

Business Connection----------

Mail Address { Street and No---------- / City and State----------

Make check payable to Chas. Eliot Warren, Treasurer

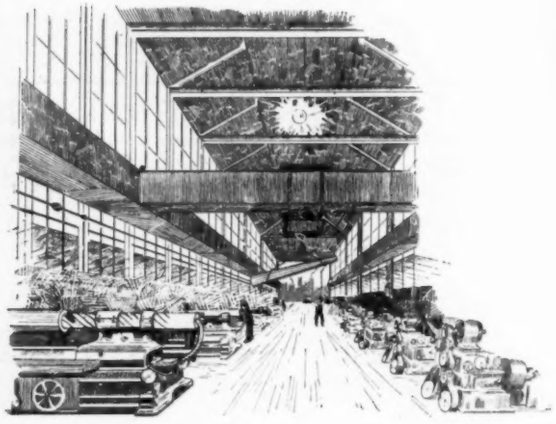
I am particularly interested in (Mark X):

------ Aircraft Armament	------ Professional work
------ Small Arms	------ Merchandizing
------ Artillery	------ Mechanical Engineering
------ Ammunition	------ Electrical Engineering
------ Motorized Ordnance	------ Chemical Engineering
------ Ordnance Field Service	------ ----------

My present business connection is----------

I wish ARMY ORDNANCE sent me at----------

----------, 1920. ----------



INDUSTRIAL WAR DEP

ORDNANCE SURPLUS IMMEDIATE

GUN BORING LATHES

The Philadelphia District of the Ordnance Salvage Board offers for sale, by negotiation, twenty-seven Gun Boring Lathes, made by well-known manufacturers of this kind of equipment as the Bridgeford Machine and Tool Works, Gisholt Machine Co., etc. These lathes are ready for immediate delivery. Terms of sale are not complicated. Full directions to purchasers regarding these lathes can be obtained from the Chairman Philadelphia District Ordnance Salvage Board, 1710 Market St., Philadelphia, Pa.

In addition to the large quantities of various commodities located in the Philadelphia District, there is also a vast assortment of materials and equipment of every kind located at the districts listed below. Write these various districts for bulletins. You may find just the kind of equipment you need and procure it at a saving over present market prices.

6—Gisholt Machine Co., Madison, Wis., Gun Boring Lathes, 24″ x 57′ bed in five sections, 1 section 7′ 8″, 4 sections 12′ 4″ each equipped with silent chain and 1 gear for motor drive, 2 lead screws, 1 3 jaw Independent chuck, 24″, 4-3 jaw steady rests, 1 cross slide with tool post attached (automatic feed), 1 bar rest with bushing attached, 1 carriage with bracket for holding boring bar (automatic feed), 1 cast iron oil tank in two sections (6 screens), 1 cast iron extension bracket for motor, motor driven no motor attached. Location: Midvale Gun Plant, Nicetown, Pa.

5—Bridgeford Mach. & Tool Works, Rochester, N. Y. Gun Boring Lathes 36″ x 72′, bed in two sections, 1 spider for saddle, 1 bar rest (bushing missing), 1 cast iron carrier, 4 jaw steady rest, 4 finding clamps complete, 1 cast iron bracket 17″ x 26″ x 7″, 1 cast iron oil tank with screens attached, 1 extra drive gear 21½ diam. x 4″ face, 2½″ bore, 3 change gears, motor drive, two required, none attached. Location: Midvale Gun Plant, Nicetown, Pa.

4—Pratt & Whitney Co., Hartford, Conn. Gun Boring Lathes, 28″ x 61′ bed in three sections, 20′ x 20′ x 21′, lead screw in two sections, 1 cast iron oil tank, 1 section assembled with head stock, chuck, driving mechanism, carriage with tool post attached, bar rest, (bushings missing) 1 gear plate, with 3 studs attached to machine, 6 cast iron legs with support plates, change gears missing, motor drive, no motor attached. Location: Midvale Gun Plant, Nicetown, Pa.

5—Pratt & Whitney Co., Hartford, Conn. Gun Boring Lathes, 28″ x 71′ bed in three sections, 21′-25′-25′. Lead screws in two sections, 1 cast iron oil tank with pump attached, 1 cast iron settling tank, 1 section assembled with head stock and chuck, carriage with tool post attached, 1 bar rest with bushings, 1 carriage with bracket for holding bar, 3 jaw steady rest (jaws missing), telescope oil feed piping complete, 6 cast iron legs with base support, 20 change gears, 1 worm gear with 3 washers and nut attached, motor drive, no motor. Location: Midvale Gun Plant, Nicetown, Pa.

4—Bridgeford Mach. Tool Works, Rochester, N. Y. Gun Boring Lathes, 36″ x 44′, 1 spider on saddle, 1 bar rest (bushings missing), 1 bronze bushing for saddle, 1 4 jaw steady rest with 2 binding clamps complete, 1 cast iron oil tank with screen attached, 1 right angle cast iron bracket 17″ x 26″ x 7″, motor drive, two motors required, none attached. Location: Midvale Gun Plant, Nicetown, Pa.

3—Bridgeford Mach. Tool Works, Rochester, N. Y. Gun Boring Lathes, 44″ x 20′, 1 cast iron bracket for plunger, 1 plant steady rest, 1 cast iron gear guard. Location: Midvale Gun Plant, Nicetown, Pa.

PHILADELPHIA DISTRICT

1710 MARKET STREET

TELEPHONE

DISTRICT OFFICES

DISTRICT.	ADDRESS.	TELEPHONE NO.
Baltimore	Columbia Ave. & B. & O. R. R.	
Boston	19 Portland St	Army Wire.
Bridgeport	945 Main St	Noble 791.
Chicago	74th & S. Ashland Ave	Superior 10,000
Cincinnati	Walsh Bldg., 3rd & Vine Sts	Main 3732.